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JANUARY 3, 1947—VOL. CLXXXIII

THE ENGINEER

A Seven-Day Journal

The New Year Honours

IN the New Year Honours List, published on Wednesday, January 1st, the following names appear:—New Barons are Mr. Charles Dukes, Chairman of the Trades Union Congress General Council in 1945; Sir Walter Layton, C.H., Director-General of Programmes, Ministry of Supply, 1940–42, and head of the Joint War Production Staff, Ministry of Production, 1942–43; and Sir Ernest Simon, M.I. Mech. E. The Order of Knight Bachelor is conferred upon Brig.-General A. C. Baylay, Chairman of the Birmingham and District Engineering and Allied Employers' Association; Mr. Arthur Belcher Cauty, Chairman of the National Maritime Board; Mr. William Henry Coates, department chairman of the I.C.I.; Mr. Walter Norman Haworth, F.R.S., Mason Professor of Chemistry and Director of the Department of Chemistry, Birmingham University; Mr. Robert J. M. Inglis, Chief of Transport Division, British Element, Control Commission for Germany; Mr. Harold Leslie Kenward, for services to the Ministry of Supply in connection with the rubber tyre industry; Mr. Charles Percy Lister, for services as managing director of the United Kingdom Commercial Corporation; Mr. Thomas McPherson, director and general manager of the Wallsend Slipway and Engineering Company, Ltd.; Mr. William Guy Ropner, late director of the Convoy Section, the Ministry of Transport; and Mr. Ernest Woodhouse Smith, late President of the Institute of Fuel. Rear-Admiral (E) Ford and Air-Commodore F. Whittle, R.A.F., become C.B. in the Military Division. In the Civil Division Mr. H. E. Aldington, Chief Highway Engineer, the Ministry of Transport; and Mr. H. Townsend, Director of Telecommunications, G.P.O. become C.B. The G.B.E. in the Order of the British Empire is conferred upon Sir William Currie, late Director of the Liner Division, the Ministry of Transport, and chairman of the P. & O. and the British India Steam Navigation Companies; Sir Frederick Joseph West, chairman and managing director of West's Gas Improvement Company, Ltd.; and Sir William Valentine Wood, president of the executive of the L.M.S. Railway Company. Mr. F. E. S. Beavan, director and general manager of the Mountstuart Dry Docks Company; Mr. W. G. Carter, chief designer, the Gloster Aircraft Company; Mr. R. A. Davis, late Departmental General Director of Royal Engineer Equipment, the Ministry of Supply; Mr. J. Jamieson, engineer and manager of the Edinburgh Corporation Gas Department; Mr. T. D. Jones, Professor of Mining, the University of Wales; Mr. J. L. P. Kent, Superintendent of the Ship Division, National Physical Laboratory; and Mr. S. F. Steward, Director-General of Machine Tools, the Ministry of Supply, become C.B.E.

Retirement of Mr. Henry Woodall

MR. HENRY WOODALL, whose retirement from the post of deputy governor of the Gas Light and Coke Company, took place on December 31st, had served the gas industry for more than sixty years. He was an original director of the South-Eastern Gas Corporation, Ltd., and was appointed director of the Gas Light and Coke Company in 1913 and deputy governor in 1926. He received his training with the firm of Corbet Woodall and Son, consulting civil engineers, who specialised in the erection and control of gas undertakings. In connection with this work Mr. Woodall travelled widely both in the United Kingdom and abroad. His firm acted as consulting engineers to the Imperial Continental Gas Association, and at one time was looking after works in Vienna, Amsterdam, Copenhagen, Antwerp, Brussels and Berlin. For two years, 1886 to 1888, Mr. Woodall was in Australia and later on, in 1893, he spent a further two years in South Africa. His firm had a considerable parliamentary practice, and Mr. Woodall was frequently called upon to give evidence in connection with Private Bills in the Houses of Lords and Commons. He was well known as an expert witness in arbitration and rating cases, and his services were often in demand as an arbitrator. Among other interests, Mr. Woodall is chairman and managing director of the British Gas Light Company, Ltd., and the Tottenham and District Gas Company. He is also deputy chairman of the Croydon Gas Company and chairman of the Ipswich Gas Light Company and the Danish Gas Company. He is a member of the Institution of Civil Engineers and the Institution of Gas Engineers. Mr. F. M. Birks has been appointed deputy governor in place of Mr. Henry Woodall. Mr. A. E. Sylvester, governor, is retiring, but will continue as a director of the company. The directors of the Gas Light and Coke Company have elected Mr. Michael Milne-Watson, the son of the late Sir David Milne-Watson, to be governor.

Chief Inspector of Factories Report

THE annual report of the Chief Inspector of Factories, Mr. H. E. Chasteney, for the year 1945 has just been published by the Stationery Office, price 2s. net. With regard to the deterioration which took place during the war period, the report states that shortages of material and labour have caused difficulties in obtaining specialised guards for machines and some have had to be of a makeshift nature. For urgent war contracts cases occurred in which machines were started up and continued to run for some time without proper fencing. On the whole, however, there has not been such a general and marked deterioration in the safeguarding of machinery as took place in the previous war. The percentage of power machinery accidents continues to fall steadily year by year. In the conversion of plants from war to peace production this matter will need careful attention, especially in cases of deferred maintenance and repair work. A noteworthy feature of the last four years has been the continued fall in the number of fatal accidents. The latest figure is little more than half the peak figure of 1646 in 1941 and is the lowest reported during the last ten years. In 1945 there was an equal decline in the number of non-fatal accidents. Useful accident tables and curves are given in the report. A higher accident rate amongst male young persons than amongst men is noted, and in one large works a system of "works guardians" has been adopted. There was a fall in the number of accidents in shipyards and ship repairing establishments, and in Scotland it is estimated that this fall is about 14 per cent in the number of accidents per 1000 persons employed. Reference is made to the need to keep up the influence and usefulness of the Safety Museum at Westminster. Colour is being introduced into workshops and factories with good effect. In addition to the main report by the Chief Inspector, there are other sections on electrical risks and the engineering and chemical branches, while industrial health is also dealt with. These sections are written by the senior inspectors of the different branches.

British Shipbuilding and South America

THE Shipbuilding Conference announces that the British shipbuilding industry has appointed Mr. Thomas W. Pears as its representative in the South American Continent. Mr. Pears, who is forty-eight, has had long shipbuilding, shipowning and consular and information experience in Spain and South America. This appointment follows the visit of the British Shipbuilding Mission to several of the South American countries earlier this year. Mr. Pears, who recently arrived in Argentina, will be establishing his headquarters in Buenos Aires, and from there will make regular visits to all South American countries interested in the purchase of ships to be built in Britain. His function will be essentially that of a liaison officer in South America for the British shipbuilding industry as a whole, his aim being to foster and develop interest in the Latin American market in the services offered by the industry and to enhance the relations already established between the industry and South American shipowners. It will also be his responsibility to keep the South American market fully informed of progress in the British shipbuilding industry, and, through the Shipbuilding Conference in London—the central commercial trade organisation of that industry—to advise British shipbuilders of the technical and operational requirements of the shipping services of the Latin American countries. His activities and functions will therefore be entirely supplementary and ancillary to the services normally rendered by individual British shipbuilding firms, either direct by special visits to the countries concerned as required or through their resident agents or brokers.

North-Western Divisional Coal Board Appointment

IT is announced that Mr. H. Watson-Jones, of the Metropolitan-Vickers Electrical Company, Ltd. has been appointed Divisional Chief Electrical and Mechanical Engineer to the North-Western Divisional Coal Board with effect from January 1st, 1947. Mr. Watson-Jones was born in 1899 and received his practical training first with the Mersey Docks and Harbour Board and later at the Metropolitan-Vickers Trafford Park works. In the intervening period he saw war service in the Navy and took his engineering degree course at Liverpool University. Subsequently he was employed at Metropolitan-Vickers as installation engineer, chiefly on industrial and power supply equipment, as liaison engineer in the United States and as senior engineer in the general engineering department, where he was responsible for complete power supply and distribution schemes at home and overseas. In 1937 Mr. Watson-Jones was appointed general manager of the Birtley Company, Ltd., Co. Durham, manufacturers of coal preparation and mechanical handling plant, but in 1939 he returned to Metropolitan-Vickers as head of the mining department. In that position he dealt with many comprehensive electrification schemes for collieries and mines, and was responsible for the commercial and technical features of many large electric winder installations in South Africa and Australia, as well as in this country. Mr. Watson-Jones has published many technical articles in leading engineering journals and has read papers, chiefly on colliery electrification, to various engineering institutions.

Atomic Energy in 1946

ON the purely scientific side of nuclear physics little or no information concerning fresh developments was disclosed during 1946 in any country. It is, however, known that physicists of different nations continued their studies with unabated activity, and it can be taken for granted that in this field, with so much yet remaining to be discovered, the year was not altogether fruitless. Sundry hints have been dropped suggesting that progress has been noteworthy and that research has revealed new means of producing fissile material of increased power and at very greatly reduced cost. Intense secrecy, however, surrounds the investigations of the physicists of all nations engaged upon the study of nuclear energy, and it is improbable that information of scientific interest regarding the progress they have recently made will be published at any time in the near future.

The Bikini Tests

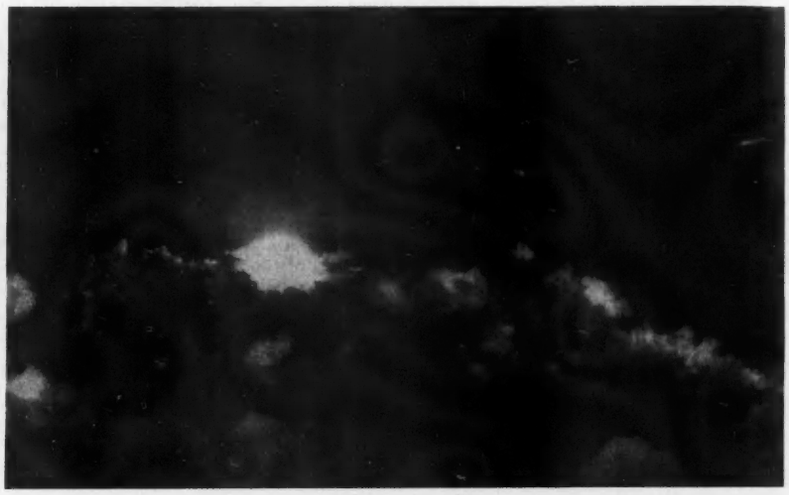
During the year the United States Navy carried out two atomic bomb tests at Bikini Atoll, in the Pacific. The first test was made on July 1st, and was designed to reveal the effect on a fleet of assorted ships produced by the explosion of a plutonium bomb exploded in the air above them. The burst, it is understood, was made at a height of 400ft to 600ft. The second test, carried out on July 24th, was planned to reveal the effect of an underwater explosion. The depth at which the bomb burst has not been revealed, but it could not have been greater than 180ft, the depth of the lagoon, and was probably between 50ft and 100ft.

No official report on the detailed results of the tests has been published and none need be expected. It is commonly believed that the effects were less devastating than they were expected to be. Judging solely by the number of ships that were sunk or damaged, many people were led to believe that the tests were comparative failures. To hold that view implies a mistaken idea of their object. The intention was not to demonstrate the destructive power of the atomic bomb—that had been sufficiently well shown at Hiroshima and Nagasaki in 1945—but to provide information that might lead to the devising of means for the protection of ships and their crews from the immediate and after effects of atom bomb attack. In some respects the data required could be obtained better from the ships that survived the test than from those which sank before they could be examined. To that end the vessels comprising the target fleet were disposed at various distances from the centre of the explosion and at various alignments to their radii from it.

In general the main lessons learnt from the tests seem to have been the virtue of dispersal as a protection against atom bomb attack and the deadly effect of the induced radio activity which accompanies an atom bomb explosion. On the first point it has been reported that ships at a radius up to one-eighth of a mile from an atom bomb exploded in the air can be expected to sink, up to a quarter of a mile to be severely damaged, up to half a mile to suffer moderate damage and up to a mile to experience trivial damage. The scorching effect of the explosion appears to be the least damaging of its accompaniments. Scorching of exposed paintwork is said to have been noticeable up to a distance of a mile, but it was confined to the surface layer. Even at as close as half a mile the undercoat of paint was not affected. The blast effect cannot, on the information at public disposal, be assessed with similar assurance, but some unofficial observers are of the opinion that many men would survive the blast from a bomb exploding in the air half a mile away. The radius over which severe, moderate or trivial damage is inflicted on ships appears to be greater in the case of a bomb exploded in the air than in that of an underwater explosion. On the other hand, the underwater bomb would seem to be the more effective when judged by the number of ships actually sunk.

The induced radio activity, it is stated, is to be regarded as the most menacing effect of an atom bomb explosion. It persists for some days on the ship attacked and in the surrounding water and is particularly marked in sodium-bearing substances, such as salt and soap. Members of the crew of an attacked ship might survive the scorching and blast effect only to succumb later on to the accumulated effect of the induced radio activity. It has not been revealed at what distance from the centre of the explosion danger from induced radio activity ceases to be effective. It would appear, however, that it is more potent in the case of an underwater explosion than in that of an air burst.

On the negative side it can be asserted with assurance that neither of the test bombs induced earthquakes, tidal waves or hurricanes. In the underwater test the explosion sent up a column of water over 2000ft in height. At a distance of 1000ft from the centre of the burst the waves sent out were estimated to be 90 ft high. At a radius of 2000ft their height had fallen to 60ft and at 15,000ft to less than 10ft. Twenty miles away, at the end of the lagoon, their height was less than a foot. The wind caused by the air burst seems to have diminished with distance in accordance with much the same approximately inverse square law.



EARLY STAGE OF FIRST BIKINI TEST BOMB EXPLOSION

Control of Atomic Energy

On January 24th the General Assembly of the United Nations, meeting in London, established a commission "to deal with the problems raised by the discovery of atomic energy and other related matters." This commission was instructed to make proposals for (1) the international exchange of basic scientific information for peaceful ends; (2) the control of atomic energy to the extent necessary to ensure its use only for peaceful purposes; (3) the elimination from national armaments of atomic weapons and of all other major weapons adaptable to mass destruction; and (4) the creation of effective safeguards, by way of inspection and other means, to protect complying States against the risks of violations and evasions.

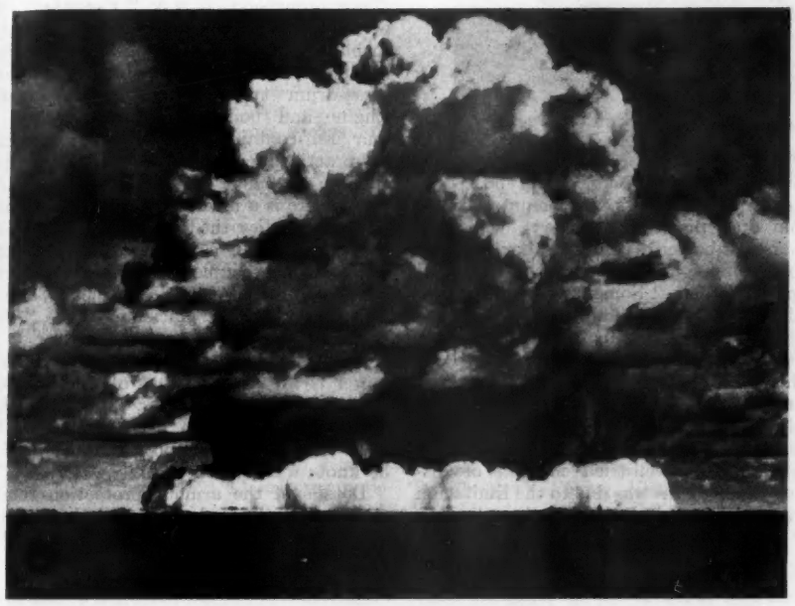
This Atomic Energy Commission, comprising representatives of twelve nations—Australia, Brazil, Canada, China, Egypt, France, Mexico, Netherlands, Poland, Russia, the United Kingdom and the United States—held its first meeting on June 14th and set up various committees, including a Legal Advisory Committee and a Scientific and Technical Committee. On the legal side progress has been slow. The nations concerned have exhibited wide differences of opinion regarding the political aspects of the subject. While all appear to be agreed that international control of atomic energy for destructive purposes is desirable or imperative, there has been great hesitation by some, particularly by the United States, regarding the revelation to all the world of secrets which they believe they alone possess at present. Most of the nations also dislike the idea of consenting to the inspection of their activities on the ground that it would infringe their sovereignty. For the time being something of a deadlock prevails in the international political aspects of the subject.

Yet while the politicians are discussing it the urgency of reaching agreement increases. A body of American scientists headed by Einstein has issued a powerful and solemn warning that new and more deadly atomic bombs are in sight, that there is no practicable defence against them and that unless their manufacture is effectively prohibited by international agreement their use in a future war will be inevitable. Other authorities have emphasised the fact that new weapons of mass destruction more threatening to humanity even than the atomic bomb are now being actively developed and call at least as urgently for international control. The nature of these new weapons has not been fully disclosed but it has been hinted that they include bacteriological and poison gas devices.

While the politicians wrangled the Scientific

and Technical Committee of the commission discussed among themselves whether it was technologically practicable to devise means for the effective control of atomic energy as a means of waging war. The representatives on this Committee of all the eight nations came unanimously to the conclusion that it was practicable. The study of a report issued by this Committee fails to make clear the precise grounds on which it based its conclusion. Indeed, the report leaves us with the impression that the Committee was anxious to reach an affirmative conclusion more because such a conclusion was eminently desirable than because of the weight of the evidence in its favour.

The Committee's report emphasises the possibility of effecting control at the very source—the mining of uranium and thorium ores—and asserts that safeguards at this stage appear to be "not too difficult." The proposed nature of these safeguards is not specified, but it is recognised that, whatever they might be their imposition would become complicated if, as is possible, other elements besides uranium and thorium were discovered to be amenable to treatment for atomic energy production. The Committee also seems to believe in the possibility of exercising effective technical control at the plants producing concentrated "nuclear fuel." Here the subject is complicated by the fact that the processes employed for the production of nuclear material for bombs is in large part identical with those for the production of similar material for legitimate peaceful purposes, such as power generation. There is thus a decided danger that the peaceful product might be deflected by an unscrupulous nation to the production of atomic bombs. The suggestion is made that it might be possible to dilute or denature the nuclear material in such a way as to render it unsuitable for use in bombs while leaving it in a condition suitable for its use in a power plant. This suggestion has been seized upon eagerly by some people as a possible means of securing to mankind the benefits of nuclear energy for peaceful purposes without incurring the risks of its employment in war for mass destruction. Nevertheless, it requires clarification. Denaturing is physically possible, but, it may be asked, would it not involve the production in the first instance of concentrated material and would not the denaturing process be carried out in the works producing the concentrated material? Further, is there any assurance that the denatured material could not fairly easily be revived in concentrated form? Until we have the answer to these questions we can hardly accept the denaturing idea with any assurance that it will effectively bar the production of nuclear material for war purposes.



UNDERWATER BIKINI TEST BOMB EXPLOSION

Atomic Energy and Power

Considerable discussion took place during the year concerning the peaceful applications of atomic energy, particularly its use for the production of power. No announcement was made of any successful achievement in this direction even on a small scale, but from the physical point of view the possibilities are good and doubtlessly experiments are in progress in more than one country.

During September a report was published on this subject in the United States. This report was prepared by a committee of engineers and scientists and was submitted to the United Nations Atomic Energy Commission by Mr. Bernard Baruch. Its main object was to provide an estimate of the cost of generating power by means of atomic energy and to compare it with the corresponding cost of generation in an ordinary coal-fired station.

The report suffered considerably from the omission or suppression of detailed information essential to permit its conclusions to be examined and checked. It estimated that a nuclear power station with a capacity of 75,000 kW complete with all equipment could be built for about 25,000,000 dollars and that, taking interest charges at 3 per cent, the operating cost, at full capacity, would be 0·8 cent per kilowatt-hour. The comparable cost of a similar coal-fired station would be 10,000,000 dollars and with coal at 7·5 dollars per ton delivered the operating cost would be 0·65 cent per unit. If coal rose to 10 dollars per ton, the report added, the operating costs of the two stations would be equal.

How the figures for the nuclear power plant were arrived at we do not know. The important factors omitted from mention are the cost of the nuclear fuel and the cost of the equipment, additional to that in a coal-fired station, required in the nuclear power station. In the absence of such information we do not feel inclined to accord to the report the authoritative character claimed for it by its sponsors. We are indeed denied the opportunity even of deciding whether it is worthy of serious consideration. On one point, however, positive comment can be made. A station of 75,000 kW capacity would not be considered large to-day. That amount of power and more could be generated by a single turbo-alternator. The present installed capacity of Battersea B station is 343,000 kW, and it is planned eventually to increase it to 4–500,000 kW.

On this point there is a passage in the report of the Scientific and Technical Committee of the Atomic Energy Commission which deserves consideration. Taking the world's annual output of uranium ores at 1000 tons (uranium content), the Committee estimates that if all the U-235 present in it—amounting to about 7000 kg—were applied to destructive ends, there could be produced each year from 70 to 3500 atomic bombs. If alternatively the U-235 were used as nuclear fuel in power stations having an overall efficiency of 10 per cent, electric power amounting to two million kW could be produced for a year. This gives us some idea of the extent to which nuclear energy could be used in place of the thermal energy of coal. Doubtlessly the world's output of uranium—and thorium—is capable of being, and indeed may already have been, stepped up considerably above 1000 tons a year. Doubtlessly, too, methods of increasing the efficiency of its use in power stations are possible. Let us cover these factors by multiplying the Committee's two million kilowatts by five. For the year 1942–43 the total capacity of 365 authorised generating stations in this country was 11,679,000 kW. To-day it is probably in the neighbourhood of 12,000,000 kW. We thus reach the remarkable conclusion that, even allowing a liberal margin for development and improvement, the world's annual output of uranium is insufficient, if diverted entirely to this country, to meet our requirements for electrical power. If the output were distributed with reasonable fairness over all nations it would seem to be impossible that power derived from nuclear energy can replace more than a minute fraction of that now generated by coal-fired and hydro-electric stations.

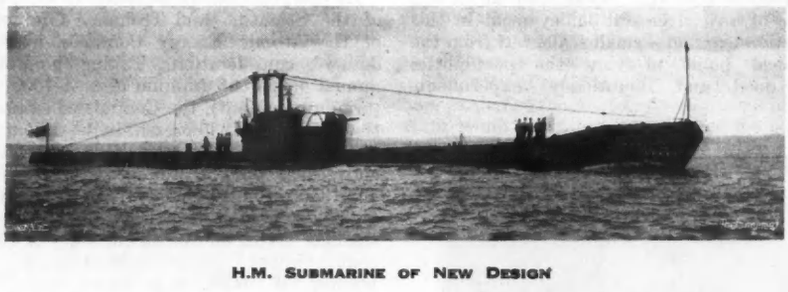
That conclusion requires a word of qualification. It is well known that nuclear fission in the present state of the art results in the conversion into energy of only a very small part of the mass of the fissile material. If physicists, as they may well do, succeed in discovering some means of increasing the conversion ratio the whole picture of the generation of power from "nuclear fuel" will be considerably altered. The possibility exists that the world's supply of nuclear fuel is not limited by the amount of U-235 present in Nature. By nuclear reactions two "artificial" elements, PU-239 (or plutonium) and U-233 (unnamed at present), can be derived from uranium and thorium, respectively. Both these elements are available as nuclear fuels for power production and both are generated during the consumption of U-235. It is not, however, at present publicly known whether they are generated in sufficient amount to replace the original materials. If they are, the world's stock of U-238, which is one hundred and forty times as plentiful as U-235, and also its stock of thorium, which is more plentiful than uranium, will constitute potential nuclear fuels for power production.

Naval Construction in 1946

By FRANCIS McMURTRIE, A.I.N.A.

No. I

IN all the Allied navies, construction during 1946 proceeded at a much reduced pace compared with the war years. A certain percentage of the tonnage in hand was cancelled, while the completion of many units was deferred, partly for the sake of economy and partly in order to modify designs in the light of the latest weapon developments.



H.M. SUBMARINE OF NEW DESIGN

Another noticeable feature was the transfer to other flags of ships regarded as superfluous to the peacetime establishment by the British and United States Navies, though eagerly acquired by their new owners as an alternative to building fresh tonnage.

British Navy

With the completion of H.M.S. "Vanguard," in April last, the main particulars of her design have been released. These bear out the forecast that appeared in these columns a year ago. Of 42,500 tons standard displacement, the full-load figure is undoubtedly over 50,000 tons. Thus, the "Vanguard" is the largest ship ever constructed for the Royal Navy, exceeding by 400 tons the displacement of the "Hood," culminating capital ship design of the 1914–18 war. In length the "Vanguard" is some 30ft less than the "Hood," but her beam of 108ft is slightly greater. In main armament the two ships are identical, each mounting eight 15in guns of the same mark arranged in four twin turrets, two forward and two aft; but the "Vanguard's" guns enjoy the advantage of the latest system of radar control.

One noteworthy fact is that the 15in pieces of the "Vanguard" are fully 30 years old. They were first mounted in the "Courageous" and "Glorious" when those two ships were first completed as fast cruisers of 18,600 tons in 1917. When both were transformed into aircraft carriers, between 1924 and 1930, their 15in guns were landed and added to the reserve of weapons of that calibre maintained for battleships of the "Queen Elizabeth" and "Royal Sovereign" classes, and for the "Hood." Subsequently, following the loss of the "Royal Oak," "Barham" and "Hood" during the war, the number of these guns was found to be well in excess of replacement needs. Thus, the surplus became available for the main armament of the "Vanguard."

It had originally been intended that the name "Vanguard" should be borne by the fifth ship of the projected "Lion" class, all the ships of which were cancelled. They were to have been armed, it is understood, with 16in guns; but since it takes longer to manufacture such heavy pieces than it does to build ships to carry them, the opportunity of utilising some of the spare 15in guns must have been a welcome one.

In secondary armament the "Vanguard" follows the "King George V" type. Like the ships of that class, she mounts sixteen 5·25in dual purpose weapons; while her anti-aircraft batteries comprise about seventy Bofors 40mm guns, the majority arranged in groups of six. Some are mounted immediately over the square-cut stern, where they are particularly conspicuous as one approaches the after gangway.

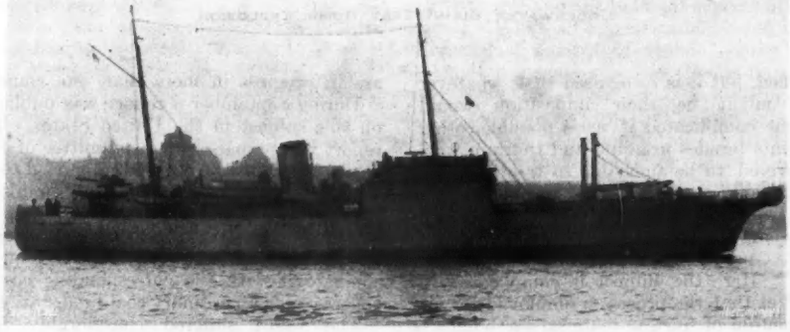
There will be general approval for the reversion to the four-turret arrangement, as employed in the "Queen Elizabeth," "Royal Sovereign" and "Hood" designs. Departure from this well-tried method of disposing the big guns was due to the limitation by treaty of capital ship displacement to 35,000 tons in the years between the two great wars. This restriction obliged our naval constructors to resort to every possible expedient to save weight. Most fruitful of these expedients was the endeavour to concentrate the heavier part of the armament in the least space in which it could be made effective. Thus the "Nelson" and "Rodney" were made to carry their nine 16in guns in three triple turrets forward of the bridge, while in the "King George V" class the ten 14in pieces are mounted in one quadruple and one twin turret forward, and a second quadruple turret aft. Neither of these alternative methods of disposing the main armament can be considered so satisfactory as that adopted in the "Vanguard."

The "Vanguard," was ordered in March, 1941, and was laid down by John Brown and Co., Ltd., in the following October. During the course of the war, her design underwent gradual modification, in accordance with the latest scientific developments. As she emerged five years later, she must have been a somewhat different ship from the profile first portrayed by her designer, Sir Stanley Goodall. The close grouping of masts and funnels, with the pronounced flare at the bow (see Supplement) owes something to American influence; though it was in the British fleet that the idea of keeping spray off the forward control positions by this flared bow first originated. The funnels are of novel form, streamlined, with the caps turned over towards the stern. Their shape was evolved after a series of wind-tunnel experiments in order to prevent exhaust gases interfering with the functioning of the after gunnery control.

For propulsion, H.M.S. "Vanguard" depends upon Parsons single reduction geared turbines, which are supplied with steam by eight water-tube boilers of the Admiralty three-drum type and drive four shafts. Engine and boiler-rooms are arranged in four self-contained units, thus rendering it practically impossible for the main engines to be put out of action by a single hit. There is a novel method of oil burning which embodies the benefits of four years' research work. Greatly improved ventilating arrangements, coupled with a dehumidifying system operated on the jet principle, should further increase the efficiency of the "Vanguard's" propulsive arrangements.

It is understood that the designed horsepower is the same as that of the American "South Dakota" class, 130,000 s.h.p. No trial figures have been published, but there is reason to suppose that a speed of 30 knots was approached.

Details of the armour protection remain secret, but it may be assumed that it is at least equal to that of capital ships of similar displacement built for other navies. In photographs the main side armour can be seen quite clearly; and it has been stated that the 15in turrets are those originally installed in the "Courageous" and "Glorious." This may well be questioned, since the gunhouses of those ships were reputed to be protected by a maximum thickness of 9in, whereas most modern battleships have turret armour from 12in to 18in thick.



H.M. CABLE SHIP "BULLFINCH"

As a flagship, the "Vanguard's" full wartime complement would include about 100 officers and 1900 petty officers and men. The accommodation for the ship's company

is exceptionally good. On the lower deck there are six special dining halls, to which food is supplied through serving hatches communicating by lifts with two galleys on the main deck above. Messes are of the enclosed type, in which men can "get their heads down" with less chance of disturbance than in the open type of mess formerly found in all H.M. ships. These messes are exceptionally well furnished, with tubular steel furniture and cushions. Even the few mess stools included in the equipment are cushioned.

A cinema seating 130 is the first which has been included as a feature of the design of a British warship. It is also used every day for the time-honoured ceremony of issuing the rum ration. Yet another novelty is the ship's laundry, which has proved almost embarrassingly popular—so much so that it is often necessary to put out notices to warn men that no more garments can be taken for a time. Shortage of space for sorting purposes is the main difficulty in dealing with a large number of articles at a time.

Coat hangers are fitted to all seamen's lockers; and there are special shoe lockers, cupboards for personal effects, and racks in which attaché cases can be stowed. Mess traps such as cups, plates and dishes are made of plastic material, which cannot be broken, and are cleaned and dried by machinery. This advance in the standard of comfort on the lower deck can clearly be traced to American sources.

The radar installation is exceptionally extensive and complete, designed to give instant warning of the approach of aircraft and to add immensely to the efficiency of gunnery direction, based upon the principle of remote control. The whole of the main or secondary armament can be laid, trained and aimed from the fire director aloft with a degree of accuracy never surpassed.

Automatic adjusting gear for the degaussing system of protection against magnetic mines is another item that should be mentioned. The damage control arrangements are exceptionally thorough, and are claimed to be the most effective yet contrived. Every effort has been made to ensure that, in the event of flooding through heavy damage, the flow from the leak shall be localised and any list rapidly adjusted. The main pumps are placed at a sufficiently high level in the ship to preclude their being flooded out easily.

As compared with the "Hood," there is one important advantage which the "Vanguard" possesses. This is a considerably higher freeboard. When the "Hood" was steaming at high speed, her quarterdeck was completely swept by the sea and rendered temporarily uninhabitable, the utmost care having to be taken that all hatches were tightly closed. This could scarcely occur in the "Vanguard," whose quarterdeck stands relatively high out of the water.

In view of the opinion expressed by her commanding officer, Captain W. G. Agnew, C.B., C.V.O., D.S.O., R.N., that the "Vanguard" is likely to be the last battleship of her type built, it has seemed well that a fairly full account of the ship should be included in this article.

New aircraft carriers completed for the Royal Navy during 1946 were two, the "Theseus" and "Triumph," (see Supplement) built by the Fairfield Shipbuilding and Engineering Company, Ltd., and R. and W. Hawthorn, Leslie and Co, Ltd., respectively. They are sister ships of 13,350 tons standard displacement, the last two units of the "Colossus" class. Their length overall is 694ft, maximum beam across flight deck 112ft 6in, and mean draught 21ft 4in. In these ships the flight deck has been strengthened to enable aircraft weighing as much as nine tons to be taken on board if necessary. The sponsons can be dismantled to the extent of 3ft 6in on each side to allow the ships to pass through the locks of the Panama Canal.

To minimise the effects of hits in that region, engine-rooms and boiler-rooms are arranged *en échelon*. Parsons geared turbines of 40,000 s.h.p., turning two shafts, are equal to a speed of 25 knots. There are four boilers of the Admiralty three-drum type, with a working pressure of 400 lb.

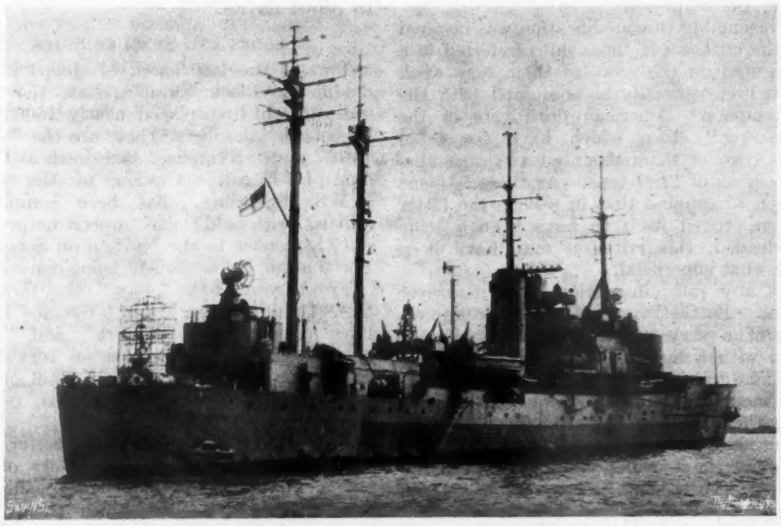
Messing arrangements in these ships follow the general lines of those in the "Vanguard."

Progress on the six 14,000-ton fleet carriers of the "Majestic" class, all launched during 1944–45, seems to be practically at a standstill. At least two of them, the "Hercules" and "Leviathan," have been towed away from their building yards to be laid up for the time being and completed at some future date. In the case of the "Terrible," at Devonport, this date is rumoured to be 1948; but official intentions on the subject are by no means clear.

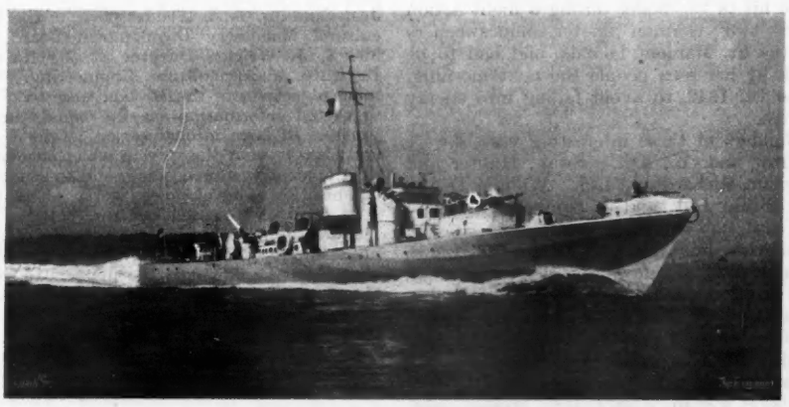
No new cruisers were completed in 1946. Work on the 8000-ton "Blake," "Defence" and "Tiger," and the larger "Bellerophon," has either ceased for the time being or is proceeding very slowly. In the case of the "Defence," launched in September, 1944, there had been every expectation that the ship would be completed during the past year, as she was well advanced. It is to be hoped she will not repeat the unhappy experience of H.M.S. "Emerald," launched in May, 1920, and not completed until January, 1926.

Destroyers passing into service last year included several of the "Battle" class, with some belated units of the four "C" flotillas. The latter are now known to be slightly improved "repeats" of the "Zambesi" class, with the same standard displacement of 1710 tons and main armament of four 4·5in dual-purpose guns. Only the first flotilla—the "Cæsar" group—have eight torpedo tubes, the remainder carrying but four in order to reduce top weight. Four of the latest of the "C" class have been acquired by the Royal Norwegian Navy.

It is now known that three flotillas of "Battles" are to be completed out of the five originally ordered. All these are of 2315 tons standard displacement except the leaders, which are of 2325 tons. The first two flotillas mount four 4·5in guns in twin turrets



RADAR TRAINING SHIP H.M.S. "BOXER"



STEAM GUNBOAT H.M.S. "GREY GOOSE"

forward, with from twelve to fourteen 40-mm Bofors as secondary and close-range A.A. armament, and eight torpedo tubes. But in the third flotilla, understood to comprise the "Agincourt," "Aisne," "Alamein," "Barrosa," "Corunna," "Dunkirk," "Jutland" and "Matapan," there is a fifth 4·5in mounted immediately abaft the funnel, and the tubes number ten, though there are fewer Bofors pieces.

Presumably this modification was inspired by the criticism of these ships (referred to a year ago) on the score of their very weak stern fire, especially as compared with the contemporary American destroyers of the "Gearing" class, which have six 4·5in guns (two of them mounted aft) on a displacement of 2400 tons. As there is some reason to suppose that in service the latter design proved itself to have been a trifle overloaded, this criticism may have been somewhat superficial.

At any rate, inspection of a destroyer of the "Battle" type gives one the impression of a very well-designed and efficient ship, with a fighting value far superior to the light cruiser of an earlier period. Officers and men of these ships seem well satisfied with them in most respects, the only complaint heard being that for the sake of economy the washing places had been left untiled. Their shaft horsepower of 50,000, though considerably less than that of their American opposite numbers already mentioned, is still sufficient for requirements, being equal to a continuous sea speed of nearly 32 knots.

Out of sixteen destroyers of the "Weapon" class ordered, only four are to be completed. These are H.M.S. "Battleaxe"—which recently completed her trials on the Clyde—"Broadsword," "Crossbow" and "Scorpion." On a displacement of 1980 tons they are to mount six 4in dual-purpose guns, together with ten torpedo tubes. Horsepower is 40,000; and novel features for British destroyers are the two Foster-Wheeler boilers, with controlled superheat. These will be the first destroyers of the Royal Navy since the "Tribal" class to have two funnels.

Little more has been published concerning the destroyers of the "Daring" class, of which it is believed only a very few will be completed. They are known to be nearly 300 tons heavier than the "Battles," and designed to mount six 4·5in guns. They will thus be the biggest destroyers ever built for either the British or U.S. Navy; but how long they will remain under construction, and whether they will ever be finished, is a moot point. At least a flotilla and a half (twelve) are reported to have been ordered in the first instance.

Submarines

Several more submarines of the new "A" class passed into service during 1946; together with at least two of the "T" type, the "Tabard" and "Teredo." Five of the latter and about thirty of the former have been cancelled, in most cases after a certain amount of work had been done.

Principal details of the "A" type so far known are: Displacement, 1120 tons; armament, one 4in, one 20-mm, three machine guns, eight torpedo tubes. In most respects these vessels appear to be modified versions of the "T" class. They are believed to be fitted with various items of equipment based on examination of the various German submarines which fell into Allied hands. It has also been reported that a submarine of another type has been re-engined for experimental purposes with a set of the latest German engines, capable of a high submerged speed.

Though about twenty-five of the "T" class and nearly forty of the "S" class remain in service, the smaller "U" and "V" types, a useful design for training purposes, are dwindling in numbers more rapidly. Not only have a great many been scrapped after hard war service, but several have been transferred to Allied navies.

Sloops and Smaller Ships

Two of the last batch of sloops of the modified "Black Swan" class, the later units of which displaced nearly 1500 tons, have been cancelled. These are the "Nonsuch" and "Nymphe," laid down at Chatham Dockyard. Another of the class, H.M.S. "Starling," has been completely refitted with additional superstructure for duty as tender to the Navigation School at Portsmouth, her armament being removed.

Two frigates of the "Bay" class, formerly the "Dundrum Bay" and "Gerrans Bay," have been renamed "Alert" and "Surprise," on refitting for special service as yachts for the Commanders-in-Chief on the China and Mediterranean stations, respectively.

Few secrets of the war were better kept than the existence and particulars of the steam gunboats, as they were called in Coastal Forces to distinguish them from their consorts, the motor gunboats. There appear to have been at least nine of these in the original programme, of which seven actually materialised in service. To begin with, they were known by numbers, but later they adopted names beginning with "Grey," of which the "Grey Goose," illustrated herewith, is an example.

On a displacement of 250 tons, these craft mounted one 3in, two Oerlikons or pompoms, eight machine guns, and two 18in torpedo tubes. Single reduction geared turbines driving two shafts are reported to have given a speed of well over 30 knots, with 8000 s.h.p. Steam was supplied from a single boiler of either Foster-Wheeler or La Mont type. That these smart little craft were ultimately discarded for patrol purposes and reduced to the *rôle* of fast minesweepers was due to their greater vulnerability as compared with the motor gunboat. This was demonstrated in the case of "SGB 7," which was completely disabled by a hit in the boiler during a night action with two German motor minesweepers off the St. Marcouf Islands, and had to be sunk by her own people the next morning, June 19, 1942, to avoid falling into enemy hands.

Builders of these interesting vessels were Yarrow and Co., Ltd.; Swan, Hunter and Wigham Richardson, Ltd.; William Denny and Bros., Ltd., and J. Samuel White and Co., Ltd.

Another unusual type of ship is H.M.S. "Boxer." Laid down by Messrs. Harland and Wolff at the end of July, 1941, as the first of a batch of twin-screw T.A. vessels they were later ordered to be converted into fighter direction ships. Only the "Boxer" ultimately passed into service.

She is a ship of 5650 tons displacement, with a length of 450ft and a speed of sixteen knots. As completed, she was a mass of radio equipment, for the aerials of which no fewer than four masts were required. Only a few light guns could be accommodated. When VJ Day dawned she was in the Mediterranean, on passage to the Far East.

Now the "Boxer" has been assigned to permanent duty as a seagoing radar training ship attached to the Navigation School at Portsmouth. Her equipment includes six high-power radar sets, sited in various parts of the ship. Additional items are radar beacons and numerous transmitters and receivers, some using R/T and some W/T, which enable the ship to communicate with any other vessel or with shore stations as well as fighter aircraft. There is also a V.H.F. direction-finder for the aural detection and direction-finding of enemy R/T transmissions. This is used as a complementary aid to radar in obtaining information about movements of enemy aircraft. Another V.H.F. radio direction-finder operating on the same principle is used for taking bearings of our own fighters' R/T and so homing them to their base. A third radio direction-finder, operating in the 60 to 1000 kc band, is used by the ship as a navigational aid. Still one other device that should be mentioned is a W/T beacon to enable aircraft to "home" themselves to the "Boxer" when uncertain of their position. Aircraft tuning to this beacon can, according to the combination of morse letters they receive, determine rapidly within a few degrees the direction of the ship of origin.

Nerve centre of the ship is the control room, which is divided into two sections, the filter room and the aircraft direction room. Information obtained by all the ship's radar sets is conveyed to the filter room by remote display equipments. Other information, such as W/T and R/T reports from other ships and shore stations, and bearings obtained by the direction-finding sets, is also brought to this room, where it is plotted and filtered in order to give a clear picture of the situation in the air within the zone in which the ship is operating.

This will give some idea of what a valuable and unique box of tricks the Royal Navy possesses in the "Boxer." It is to be regretted that her two sister ships were not completed, for if the "Boxer" became a casualty she could not readily be replaced.

(To be continued)

Farm Machinery in North America

The report of the British Farm Machinery Mission to the United States and Canada, in the summer of 1945, has now been published by H.M. Stationery Office (price 6d.). The members of the Mission were Major T. K. Jeans and Mr. T. A. Wedderspoon, of the Agricultural Machinery Development Board, and Mr. S. J. Wright, Director of the National Institute of Agricultural Engineering. The main objectives of the Mission were to obtain first-hand information on the trends in the progress of farm mechanisation in the U.S.A. and Canada, and the way in which machinery development was proceeding, and to study the organisation of development work, the relationship between research centres, colleges and manufacturers, the training of agricultural engineers, and the part played by them in machinery development. Amongst the matters to which the report draws attention are that the manufacture of agricultural machinery in the U.S.A. is concentrated in the hands of a few full-line production firms, and that there is a closer relationship between research workers, farmers, teachers, and manufacturers in applying the results of research. The Mission also observes that the success of the development of agricultural machinery by manufacturers in the U.S.A. is very largely accounted for by the favourable market and farming conditions which are not found in the United Kingdom. The report suggests that the very widest possible contacts with overseas institutions, particularly in Empire countries, should be maintained by the National Institute of Agricultural Engineering, and that the establishment of corresponding institutes throughout the Commonwealth should be encouraged.

Labour in 1946

By GERTRUDE WILLIAMS*

No. I

IT is a good habit to stop as all of us customarily do each year in the beginning of January and look back over what has happened during the twelve months that have passed. This January our annual stocktaking has particular point, for it gives us the chance to review the first complete year of peace and to try to decipher the outline of the shape of things to come in the emerging pattern of what has taken place. What have been the main lines of development? Can we yet guess what problems are likely to take the centre of the stage in the immediate future?

The dominating factor, of course, has been the change over from a war to a peace basis. The Armed Forces, which, in June, 1945, had numbered well over 5 millions, had dropped, by September, 1946, to little more than 1½ millions; and the numbers employed in the manufacture of supplies and equipment for the Forces had decreased during the same period from 3½ millions to half a million. This is a colossal conversion, representing, as it does, the movement from one job to another of close on 6½ million persons; and it is worth while to follow them a little more closely to see what occupations they have gone in to. By far the largest proportion has become absorbed into the manufacturing industries, making goods for the home market and for export; 3¼ millions more are to be found in this group than at the end of the war. Building and civil engineering account for half a million; distribution for another 300,000, and the same number have gone into the basic industries and services—agriculture, mining, transport, gas, water and electricity. A great many women have left the labour market completely as their husbands and fiancés have returned from the Forces; the numbers in paid employment have dropped by nearly a million, though here are still 700,000 more women in jobs than there were before the war. Of the remainder of the 6½ millions, there were half a million ex-service men and women on demobilisation leave, and a quarter of a million people were unemployed.

This number of unemployed may sound considerable, but it represents only 2½ per cent of the total of insured persons—a negligible proportion, for it includes, of course, those who are in process of changing from one job to another and who are not unemployed in any but this technical sense. This overall percentage, however, conceals wide variations; over the greater part of the country the figure is 1–1½ per cent: in the North-Western division it is 3; in Scotland 4½; and in Wales 8 per cent. It can thus be seen that the bulk of the unemployed are to be found in those areas that, before the war, represented the hard core of large-scale unemployment. It was to try to deal with this problem that the distribution of Industry Act was passed in 1945, though, as it turns out, the Government has acquired much more positive power to induce a more varied industrial development in these localities through the Supplies and Services (Transitional Powers) Act of the same year, and so long as the shortages of building materials and labour last, the Central Authority can provide a very real incentive to choose a site in one of the Special Areas by according a high priority to those who are prepared to establish themselves there. Some indication of the effect of this policy is given in the White Paper on Wales, which shows promise of a considerable increase in the amount and variety of employment to be offered when the necessary alterations for the conversion of factories from war to peace production are completed.

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Industrial Disputes

When we consider the extent of the upheaval in the life of the working population, we can congratulate ourselves on the smoothness with which it has taken place. It might, perhaps, savour a little of smugness if we cast an eye of comparison across the Atlantic, but we have only to look at ourselves in a similar situation to realise that we have the right to hand ourselves a bouquet or two for the way in which the country has tackled the many difficult problems with which it has been faced in the last twelve months. The end of the first World War led to the same wholesale conversion, but the result then was very different. In 1919, the aggregate of working days lost through industrial disputes by a smaller labour force than we have now was nearly 35 millions; in 1920 it was 26½ millions, and in 1921 it was nearly 85 millions. In 1945, on the other hand, less than 3 million days were lost in this way, and the first ten months of 1946 (the latest period for which figures are available) show a total of less than 2 millions. General goodwill, a readiness to co-operate on the part of both employers and workers and the efficiency of the administrative machinery can all claim a share in this very remarkable record.

At the same time, however, it must be admitted that many of the matters that have come up during the year on which there have been differences of opinion, raise questions of principle which, even where they have not yet led to strikes and lockouts, may prove to be serious threats to industrial peace in the future. Of these there are three topics—all related to one another—on which some comment is called for: the repeal of the Trade Union and Trades Disputes Act of 1927; the "closed shop," and the internal organisation of the Trade Unions themselves.

Trade Disputes Act

The Trade Disputes Act, 1927, was passed in a period of bitter industrial hostility as a direct result of the General Strike of the preceding year. It has probably done more than any other single action to exacerbate Trade Union feeling and its repeal has been in the forefront of Labour objectives ever since it was passed. Had it not been for the narrow-minded blindness of the Conservative Party in refusing to consider any amendments during the whole period of their power it is probable it would have been possible to incorporate some part of its provisions in this body of law governing trade union activities. As it is, the repeated refusal of the Conservatives to listen to any suggestion of amendment when they had the whiphand led naturally to the determination of the Labour Party to return altogether to the *status quo ante* as soon as the opportunity occurred. The Act that was passed last year, therefore, is probably one of the shortest on the statute book, for it simply repeals the whole of the Act of 1927.

There are three main results of this repeal—one which is hardly controversial, and two on which there are wide differences of opinion. Probably few would be found nowadays to argue against the right of established civil servants to join unions which are affiliated to the Trades Union Congress, a right which was taken from them in 1927, and is now restored. It was the second and third consequences on which the debate centred—the resubstitution of "contracting-out" for "contracting-in" to the political funds of trade unions, and the possible legalisation of a general strike.

Contracting-in and Contracting-out

Before 1927 the political activities of trade unions were regulated by an Act of 1913 which required trade unions to maintain a separate political fund, contributions to which could not be made a condition of membership to the union itself; but the trade union had the right to assume that any person applying for membership of the union was also accepting the obligation to contribute to the political fund unless he deliberately "contracted-out" of it. The Act of 1927 substituted the requirement that the member should "contract-in," *i.e.*, that he could not be asked to contribute unless he had deliberately signified his wish to do so. The real difference between the two, of course, is the place assigned to the not-very-politically-conscious. There is little doubt that pre-1927 many unionists continued to contribute to the political fund because they did not realise fully the implications of their membership, or because they were too lazy to take any action about it, and the political fund benefited by their ignorance or inaction. Since 1927 the emphasis has been on the other side, and the Labour Party finances have consequently suffered; for the Labour Party, which has not in the past found its chief support amongst the rich, has always had to rely much more than any other party on the collective contributions of affiliated organisations rather than on the donations of individual adherents. The trade unions and the Labour Party bitterly resented the action of the Government, which they believed an unworthy attempt to cripple them permanently. They argued that the undoubted right of an individual member of a union to support any political party he favoured was adequately safeguarded by his freedom to contract-out and that the large majority were actually sympathetic to the Labour Party, even though they might not feel their political responsibilities so keenly as to take enough trouble to put pen to paper to show their readiness to pay into the funds.

There is no doubt that the change of procedure in 1927 did have a serious effect on political funds in the 'thirties, but it is open to question whether there is much difference between the two in the long run. The need to take definite action in signing and posting a document probably lost the contributions of the "inert" who were already members of a union, but it is not difficult for a new member to be persuaded to sign the contracting-in form at the same time as his application for membership. Probably the chief long-term effect of the 1927–46 episode in this respect has been to convince unionists of the need to maintain

an attitude of eternal vigilance and of strong suspicion towards their opponents.

General Strikes

The third consequence of the repeal concerns the legality of the "general strike." Not that a general strike was mentioned in the 1927 Act—it would, in fact, be extremely difficult to define what exactly a general strike is—but the Act did attempt to make illegal a strike which was intended to coerce the Government, directly or indirectly, by inflicting hardship on the community. Lawyers disagree as to whether the Act of 1927 did really change the situation at all from what it had been before or whether it would have been possible to say, if a test case had arisen, whether a particular strike was intended to coerce the Government or not. Every strike inflicts hardship on the community or on some part of it; it would not, indeed, be very effective if it did not have some such result; and it would be extremely difficult, if not impossible, to draw a line of demarcation between "legal" and "illegal" strikes that was based on anything more objective than the opinion of the public that the particular strikers were or were not justified in their actions. The real safeguard is to be found in the fact that trade unions as much as the general public condemn the use of the strike for purely political ends, and Sir Hartley Shawcross was voicing the general opinion when he made the point that a strike directed against the Constitution "always was and always would be illegal."

The "Closed Shop"

There was a further result of the repeal of the Act, and one to which very little attention was given at the time, but which has since had important repercussions. The Act prohibited a local or public authority from making it a condition of employment or of continued employment that an employee should join or be a member of a trade union. This prohibition was, of course, removed in the general repeal, and it is this which made it possible for some local authorities to act as they have done recently in insisting on union membership for all those employed by them.

The "closed shop" raises, however, such wide issues that it cannot be considered solely from the point of view of the action of the Willesden Councillors in threatening their nurses and doctors with dismissal, nor, indeed, was it the local authorities whose action first brought the matter into popular controversy. Last August the London Passenger Transport Board announced its decision that in future its employees would be required to be members of the Transport and General Workers' Union, and threatened to dismiss those of its workers who were organised in the rival National Passenger Workers' Union. Collective agreements between employers and workers organisations to exclude non-unionists from particular types of work are, of course, no new thing. It is easy to understand that a union should feel aggrieved that non-members should continue to enjoy the benefits and privileges for which others have paid, fought and, perhaps suffered. They cannot exclude them from the benefits of the agreements since the employment of persons who need not receive the rate for the job would undermine the agreements for everybody, and the only alternative is to insist on the complete exclusion of non-unionists. What was new in the London Passenger Transport Board situation was not the insistence on union membership as a condition of employment, but insistence on membership of one particular union, and one only.

The desire of both the London Passenger Transport Board and the Transport and General Workers' Union to have only one negotiating body to speak for each side is one with which one can readily sympathise; it makes for ease of negotiation and for greater simplicity of administration of collective agreements. But, after all, simplicity and tidiness are not the chief criteria by which we must judge our social institutions—there are also the rights of the individual to be considered and neatness may be bought at too high a price.

Collective Organisations and Society

Every democratic society is continually faced with the difficult decision of striking a balance between the need for collective organisation, if generally accepted purposes are to be achieved, and the demand of the individual for freedom to pursue his own purposes without hindrance. It is, in fact, just this problem which is likely to prove the most crucial issue of the coming years. The logic of circumstance is rapidly leading to a more closely knit social organisation, which cannot help but prove more and more cramping to those whose ideas and ideals happen to diverge from those of the majority. The experience of the last half century has proved conclusively that, for our own welfare, we must submit to a greater degree of collective control than we should have found tolerable before, and for this very reason it becomes imperative to be forever on the alert to prevent the curtailment of individual freedom of action from becoming a habit. Matters would be simplified if we could make a choice once and for all of where the dividing line should be drawn between those things in which individual choice must be subordinated to the interests of the group and those in which it should have free rein, but every change in circumstances requires a shifting of the boundaries. All we can do is to examine each situation as it arises, but, as the great virtue of a democratic order of society is the opportunity it affords to its members to live lives that are as full and varied as possible, we should do well to take it for granted that freedom is always best unless a very good case can be made out for control.

With this in mind, we can distinguish three different kinds of "closed shop" on which our judgment need not necessarily be identical. The first is the one of which mention has already been made, which is the result of an agreement between organised workers and employers that non-unionists shall not be employed. On balance I believe this form of "closed shop" to be justified. It is true that theoretically there may be persons who are conscientious objectors to all forms of corporate action, and who should not be prevented from earning a living for this reason. But, as a matter of experience, the majority of non-unionists do not fall within this category. Such an agreement would not have been made unless a preponderant majority of the workers concerned were actually organised and the members of these unions have a good deal of justification for their resentment against the few who are ready to take advantage of what others have gained for them. In this instance some wrong may be done to the few conscientious objectors in order to achieve a much bigger right for the majority.

When we come to the second type of "closed shop," in which the agreement specifies the particular union to which it is obligatory to belong the position is very different. A trade union, like every democratically organised society expresses the will of the majority but this does not mean that there is universal agreement of its policy and there are, of course, many who disapprove of what is being done in their name. It might quite well happen that a minority group found itself so dispersed amongst many branches as to be quite unable to get a hearing anywhere for its views, although its total numbers formed a quite considerable proportion of the membership of the union, and only by breaking away and forming a separate organisation could they have any opportunity to express their opinions, either to the employers or to the public.

The third kind of "closed shop," such as was intended by the Willesden Borough Council when it tried to enforce trade union membership on all its employees represents, however, an even more dangerous threat to individual liberty; for here the initiative was taken by the employer and was not the outcome of any agreement between itself and its employees. It is possible, of course, to argue that an employer has the right to establish the conditions on which he is willing to offer employment and that no worker need accept the job if he disapproves of the conditions. But this same argument has been used by every hard boiled individualist who insisted that he had the right to do what he likes in his own works, and it has been as persistently denied by those who realised that this freedom to act as he likes on the part of the employer is inevitably enjoyed at the expense of his workers. If an employer is conceded the right to demand that workers should be members of trade unions, he must also be conceded an equal right to demand that they shall *not* be members of trade unions if he happens to prefer it that way. This latter demand was by no means uncommon in the earlier days of unionism and caused some of the more bitter fights between employers and workers; any employer making such a claim in these days would find the whole of liberal opinion, and not merely the strength of organised labour, arrayed against him. To lay down membership of a union as a condition of employment, when this is not simply recording a collective agreement voluntarily entered into, is as high handed an interference with matters outside the employer's authority as to insist that all workers should be members of one political party or church.

This tendency to harry everybody into his particular corral is one of the most alarming trends in modern life. In an article dealing with the labour situation it is perhaps not relevant to comment on similar development in other parts of the economic field, but, as it is often easier to appreciate the full significance of an event if one sees it in its general context instead of as an isolated happening, it is worth while to note that the Federation of British Industries implies the same belief in the "closed shop" in its anxiety to get all stragglers under an appropriate wing, and when it asks the Government to give "official recognition to efficient Trade Associations and normally use them, and them alone, in dealing with the affairs of the industry as a whole." Indeed, it is just because this desire to tidy everybody up is not confined to any one section of the community that it becomes such a pressing duty to examine carefully each new inroad on individual liberty.

(To be continued)

Aeronautics in 1946

No. I

DURING successive war years we were accustomed to note in these annual review articles, so far as security permitted, immense increments of speed, load capacity and striking power in aircraft designed for military purposes. But, quite suddenly, at the end of hostilities, the emphasis on the need for high production and warlike qualities in aircraft ended. Both Government and industry found it necessary to reorganise and concentrate on new problems of long term policy and planning for the orderly development of aircraft and services to suit the world's new needs. Although British military and naval aircraft design must never be allowed to fall below the pre-eminently high standard reached during the war, the past year gave the industry a brief period in which its resources were allowed to play fully upon the new problems.

VICKERS-ARMSTRONG "VIKING IB" MEDIUM TWIN-ENGINED CIVIL TRANSPORT

We believe it to be true to state that the measure of achievement in these problems was great. Even measured by the rapid progress in aircraft to which we have become accustomed, the year was notable for many developments. Some had to be necessarily of an improvised nature, owing to the inexorable need for time in developing new designs to the production stage, but, taking into consideration the handicaps imposed by a long period of concentration on military design, the British aircraft industry had a notable series of successes.

Radical changes in aircraft design are taking place. With the advent of the gas turbine and the practical helicopter, many design limitations have gone, and new problems of high-altitude high-speed flight are in the process of solution. Attention is now being turned to equipping large air liners with gas-turbine power units of one form or another, but time is required to bring such development to fruition. In the meanwhile, the existing United States civil aircraft are undoubtedly superior in their field, but it may well be that in the long run the scales are weighted in favour of British civil aircraft—our own giants are still in their cradles. We feel that it is significant that the British gas turbine for aircraft is in demand to power the United States giants. The very fact that we have had to design and construct from scratch may react ultimately in our favour.

Civil Aircraft

Gradually, during the past year, the pattern which has been planned for civil aircraft was taking shape. Intense activity on the part of British constructors, in accordance with Government plans for the operation of world-wide services, resulted in a start being made in equipping the British aircraft fleet with up-to-date machines of British manufacture. The foundations were laid of the three State Corporations which are to run our aircraft services—British Overseas Airways, British European Airways, and British South-American Airways.

As a legacy from the war, British services had perforce to make many conversions of military types wherever possible, and to purchase United States civil aircraft for the Atlantic line to serve during the interim period before British-designed machines are available. Thus, the trusty "Dakota," maid-of-all-work during the war, was flown on many services; the Avro "Lancastrian," and "York," the Handley Page "Halton," and various Short Bros. flying-boats, all conversions of wartime machines, maintained other services; and Lockheed "Constellation" aircraft did duty on the Atlantic crossing.

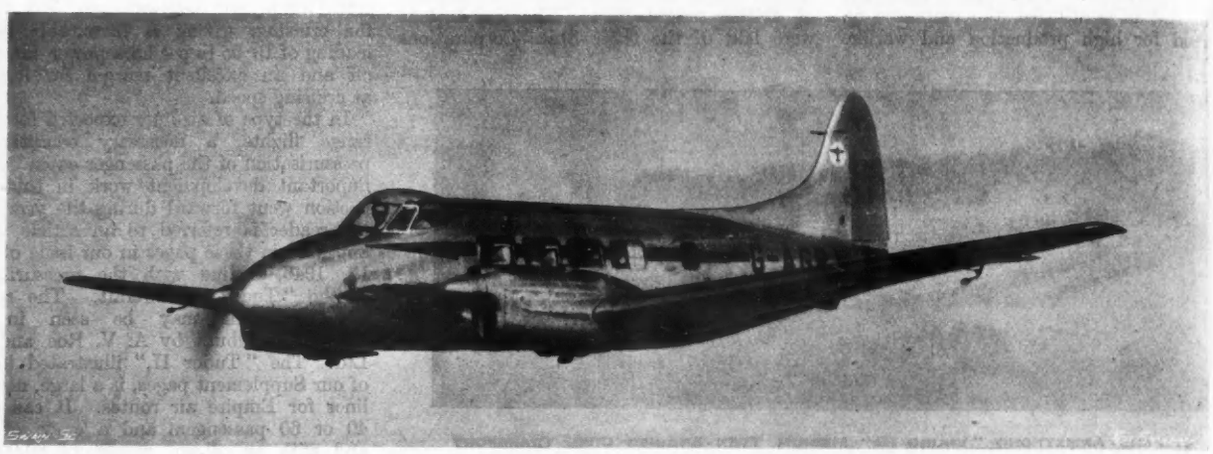
One of the first post-war British aircraft actually to enter service was the Vickers "Viking Mk. IB," illustrated in one of the accompanying engravings. Lineal descendant of the "Wellington" bomber, this aircraft is a medium, twin-engined civil transport, with accommodation for 24 passengers. The machine is designed for short and medium ranges and payload figures of 7·9 and 4·6 ton-miles per gallon are stated to be achieved for still air ranges of 710 and 1700 miles, respectively, at a cruising speed of 210 miles per hour at 10,000ft. It is now in full production and is flying on several European routes. The "Viking" is powered by two Bristol "Hercules" air-cooled radial engines and the two power plants are designed to be easily detachable and interchangeable. Each engine gives 1690 b.h.p. for take-off and 775 b.h.p. for cruising, giving a favourable power loading of 10·05 lb per horsepower for take-off and an excellent margin for long-life at cruising speed.

In the type of air-liner expected for long-range flights, a necessary condition is pressurisation of the passenger cabin. Much important development work in this connection went forward during the year, and the reader is referred to an article which appeared in these pages in our issue of May 17, 1946, dealing with the pressurisation of the "Tudor I" aircraft. The results of this work may be seen in the "Tudor II," built by A. V. Roe and Co., Ltd. The "Tudor II," illustrated in one of our Supplement pages, is a large, new air-liner for Empire air routes. It can carry 40 or 60 passengers and a crew of five, and with an all-up weight of 80,000 lb, it has a maximum level speed of 330 m.p.h. at 20,500ft, and a maximum cruising speed of 285 m.p.h. at 22,500ft. Its range with 40 passengers and baggage is 2600 miles, and with 60 passengers and baggage, 2000 miles. The span is 120ft, and length 105ft 7in. The aircraft is propelled by four Rolls-Royce "Merlin 621" twelve-cylinder liquid-cooled engines, each with maximum power of 1770 b.h.p. at 3000 r.p.m. at 4000ft. Two-speed superchargers are fitted to this type of engine. The "Tudor II" is now in production and should be seen in service shortly. In another section of this article we refer to the work which A. V. Roe and Co., Ltd., was doing in connection with flying the "Lancastrian," fitted with two Rolls-Royce jet propulsion engines.

BRISTOL "WAYFARER" TWIN-ENGINED FEEDER AIRCRAFT

Another large air-liner of which some particulars were made available was the Handley Page "Hermes." The prototypes of this machine, which also serve as the basis for the "Hastings" military transport, referred to later, have been flying during the year, and a view of the "Hermes" in flight is reproduced in one of the Supplement pages. This four-engined aircraft

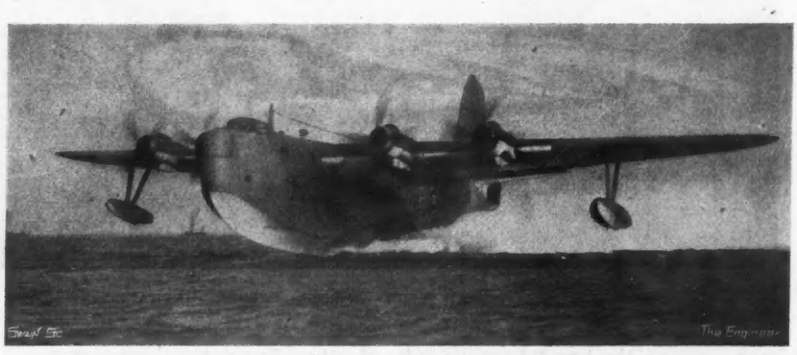
is to be pressurised and air-conditioned, and is claimed to be Britain's fastest long-range air-liner. It is at present powered by four Bristol "Hercules" fourteen-cylinder air-cooled radial engines, each with a maximum power output of 1800 b.h.p. Maximum level speed is 337 m.p.h., and cruising speed is 284 m.p.h. at 22,700ft. It is designed to carry 50 passengers and crew of five to seven. Important developments of this machine may be expected, with gas-turbine engines, a tricycle undercarriage and an enlarged fuselage to permit accommodation for 64 passengers.



DE HAVILLAND "DOVE" TWIN-ENGINED PASSENGER FEEDER TRANSPORT

Much that is of interest was going on at the works of the Bristol Aeroplane Company. The gas turbine was further developed in its various forms, and production and development of the "Centaurus" and "Hercules" piston engines with powers in excess of 3000 and 2000 b.h.p. proceeded. "Theseus" gas-turbine propeller units have already appeared and have been described. In the large air-liner field, great interest attaches to the Bristol type 167, which frequently is referred to as the "Brabazon I." Further mention of this aircraft is made in a later section of this article, dealing with aircraft under construction. At the other end of the scale is the "Wayfarer" and "Freighter" type 170 aircraft. The "Wayfarer," illustrated herewith, is a 32-seat aeroplane which is claimed, by virtue of cheapness of manufacture and operation and ease of maintenance, to bring air travel to a section of the public which cannot afford the cost of higher speeds. The cargo version, the Bristol "Freighter" is perhaps the world's most economical freight-carrying aircraft. These aircraft have a fixed undercarriage and Bristol "Hercules" engines. The "Wayfarer," at 37,000 lb all-up weight, has a maximum cruising speed of 163 m.p.h. and a range of 300 miles. The "Freighter" differs principally in that it has large loading doors in the nose.

The Miles "Marathon," illustrated in one of our Supplement pages, is another fine addition to our post-war air-liners. This four-engined medium machine is fitted with de Havilland "Gipsy Queen" engines, and is of all-metal construction. It carries 18 passengers and a crew of two, at a maximum speed of 230 m.p.h., and continuous cruising speed of 210 m.p.h., with a range of 1000 miles. The "Gipsy Queen" engines, type 71, are six-cylinder in-line, inverted, air-cooled units, each with a maximum output of 330 b.h.p., at 2800 r.p.m. at sea-level. They are fitted with single-speed superchargers. The aircraft has a tricycle retractable undercarriage and twin rudders, and the engine mountings are designed to accommodate other types of power unit without redesign of the wings. Thus when gas-turbine units driving propellers are available, it will be possible to install them without major redesign.



SHORT "SHETLAND" FOUR-ENGINED FLYING BOAT

Yet another new feeder-line aircraft is the de Havilland "Dove," which in standard form provides accommodation for eight passengers and a crew of two. Two "Gipsy Queen 71" engines, coupled to de Havilland feathering and braking propellers, give a cruising speed varying from 160 to 200 m.p.h., according to altitude. The all-up weight is 8500 lb, with fuel for 500 miles; and fuel consumption is claimed to be very nearly 6 ton-miles per gallon. This aircraft, which we illustrate herewith, is of low-wing, monoplane, all-metal construction, with nose-wheel landing gear. It is of interest to note that the cabin floors are of stressed Bakelite and plastic construction, and that lightness is contributed by the Redux process of cementing metal to metal, developed for use with earlier wartime de Havilland aircraft.

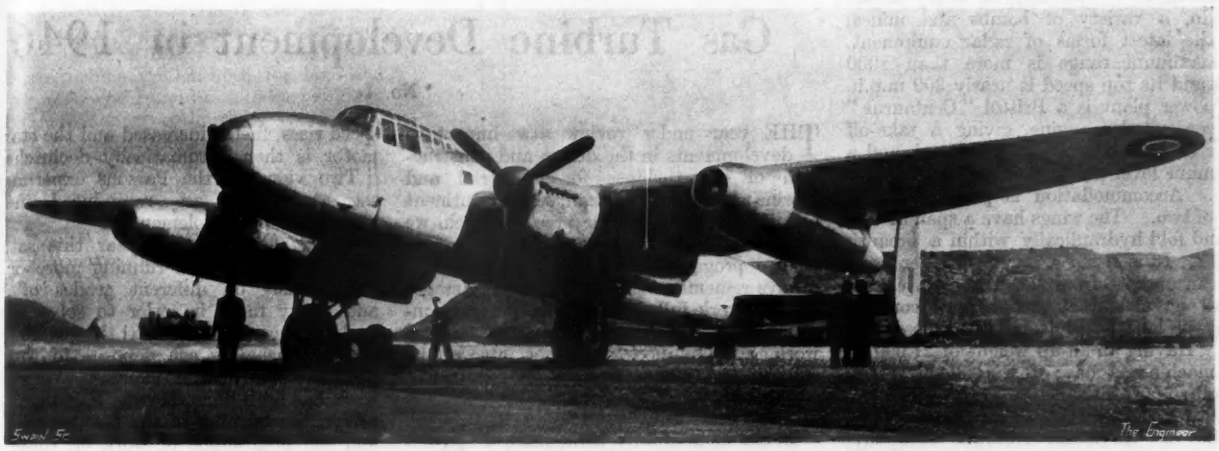
The Short "Shetland," largest of the flying-boats to be constructed by Short Bros., is a four-engined aircraft of 150ft 4in span, with accommodation for 40 day or 24 night passengers, and a crew of eleven. Its first prototype, a military version, was delivered in 1945 to the Marine Experimental Station, but the civil version prototype is now nearing completion at Rochester for delivery to B.O.A.C. It differs slightly in the design of the nose, hull and tail from the first prototype which we illustrate. The all-up weight of this machine is 130,000 lb and with Bristol "Centaurus" engines of 2500 h.p. each, it has a maximum speed of 267 m.p.h. and a range of 4230 miles.

Military and Naval Aircraft

The year was notable for a number of new types of Service aircraft, mainly for the Fleet Air Arm. For many years during the war we were handicapped in not having modern naval aircraft, but it is quite clear that limitations imposed by the need for landing and taking-off from aircraft carriers have been overcome. A convincing demonstration of this fact was given by the display held by the Society of British Aircraft Constructors at Radlett, last September, when the Hawker "Sea Fury X," the Fairey "Firefly IV," the Blackburn "Firebrand IV," the de Havilland "Sea Hornet" and "Sea Vampire," the Vickers "Seafang" and the Short "Sturgeon," represented naval aircraft which evidently suffered in no way in performance in comparison with their land-based counterparts.

The Supermarine branch of Vickers-Armstrongs, Ltd., has been responsible for many outstanding aircraft, and the news that it produced during the year a new high-performance single-seat monoplane jet fighter, so far not named other than the "E.10/44," was welcome. A view of this

machine in flight is reproduced in one of our Supplement pages. This fighter, of which weight and performance data are not yet available, is powered by a Rolls-Royce RB41 "Nene I" jet engine, producing a static thrust of 5000 lb. The jet unit is in a compartment aft of the pilot's cockpit. Air intakes, distinguishable in the view reproduced, are on both sides of the cockpit, with ducts leading aft through the fuel



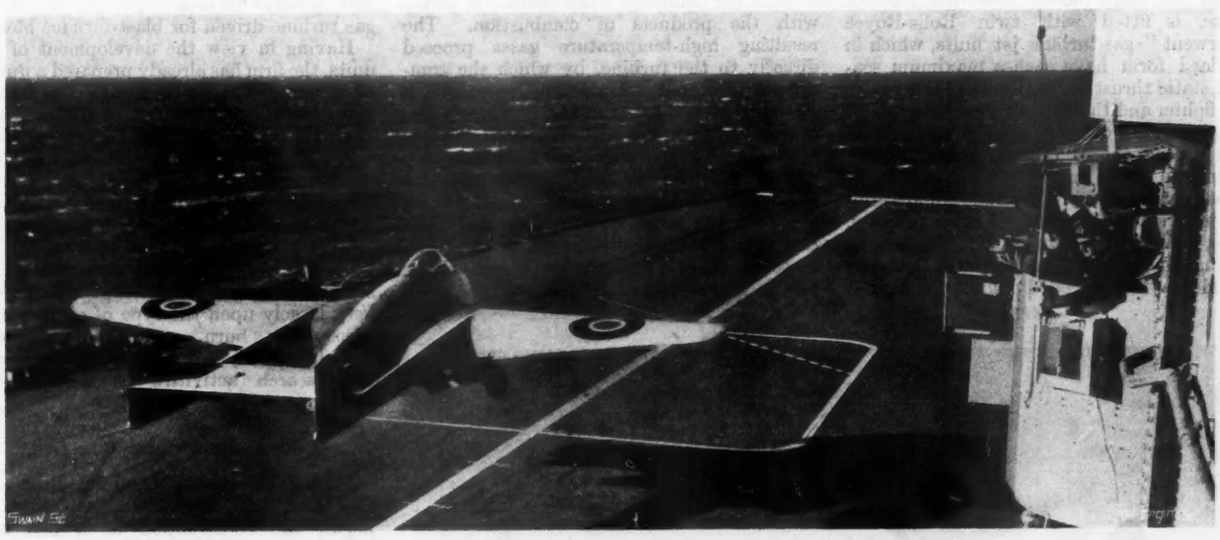
AVRO "LANCASTRIAN" AIR LINER WITH TWO ROLLS-ROYCE "NENE" JET ENGINES

tank bay to the engine compartment. The structure is of metal throughout, the nose portion affording armour protection for the pilot. High-speed flight problems have been tackled by evolving a laminar flow wing built to fine limits. Undercarriage and tailwheel are fully retractable and are totally enclosed in flight. The cockpit is pressurised and, seated well forward, the pilot has an excellent field of vision. Armament is four 20 mm Hispano guns. The span of this machine is 36ft 11in, and length 37ft 6in. Its flying qualities, as judged by the demonstration at Radlett mentioned above, are excellent.

Two other Supermarine aircraft of which details were made available during the year are the "Seafire" Mk. 47, and the "Seafang," both naval types. The "Seafire" is a direct descendant of the latest "Spitfire," Mk. 22, with fuselage basically the same but fitted with an arrester hook in the tail unit for deck landing. The wings fold to conserve space when stowing. Its Rolls-Royce "Griffon 85" engine, driving a Rotol six-bladed contra-rotating, constant-speed propeller, gives it a maximum speed of 452 m.p.h. at 20,500ft, and its service ceiling is 43,000ft. The "Seafang," illustrated herewith, is a similar naval fighter or fighter-bomber, descended from the "Spiteful," with a "Griffon 89" engine; with slightly more power available, its maximum speed is 475 m.p.h.; landing flaps are operated by hydraulic jacks, which also give a take-off flap-setting to shorten the take-off run. Specialised naval equipment includes provision for rocket-assisted and accelerated take-off.

Only one new aircraft of military character was announced by A. V. Roe and Co., Ltd.—the Avro "Lincoln II," heavy bomber, weighing 36 tons. It is powered by four Rolls-Royce "Merlin 68" engines, each with a maximum power output of 1705 h.p. The machine is illustrated herewith. Its maximum level speed is 304·5 m.p.h. at 18,200ft, and service ceiling 25,000ft. It can carry a great weight of bombs over very long distances. The total weight of bombs, fuel, military equipment and crew is 19½ tons, or 54 per cent of the gross weight. The maximum range of 4450 miles is obtained with 3000 lb of bombs at 200 m.p.h., and with a 10-ton bomb it has a range of 1350 miles at 215 m.p.h. A crew of seven is carried. All the latest developments in radar are included in the 4½ tons of military equipment. One of the most recent additions is a complete radar unit for the rear gunner, which permits him to sight his guns at a target which he cannot see.

The latest naval reconnaissance bomber, the "Sturgeon I," illustrated in one of our Supplement pages, is a product of Short Bros. (Rochester and Bedford), Ltd. Its duties include photographic reconnaissance and target towing. This is a new departure for Short Bros., a firm which has been primarily associated with flying-boats.



DE HAVILLAND "SEA VAMPIRE" NAVAL JET FIGHTER

The "Sturgeon" is a twin-engined deck-landing aircraft, with power-operated, wing-folding gear. The engines are "Merlin 140s," driving Rotol six-bladed contra-rotating propellers, giving a speed of 430 m.p.h. at combat power at 19,000ft. The service ceiling is 35,700ft. As a photographic reconnaissance aircraft it has a range of 1600 miles and equipped with bombs or depth charges, 1035 miles. A crew of three

is carried. Delivery of contracts with the Ministry of Supply has started with the three prototype machines, and the main contract will be completed by the associated company, Short and Harland, Ltd., of Belfast.

Another notable addition to the forces of the Royal Navy is the Fairey "Spearfish," of which full details were released during the year. This machine, a large single-engined torpedo and dive-bomber, forms the subject of one of our Supplement illustrations. It can carry a heavy-calibre torpedo, a variety of bombs and mines, and the latest forms of radar equipment. Its maximum range is more than 1000 miles and its top speed is nearly 300 m.p.h. The power plant is a Bristol "Centaurus" eighteen-cylinder engine, giving a take-off power of 2800 b.h.p., with methanol, and a maximum level output at 14,000ft of 2320 b.h.p. Accommodation is provided for a crew of two. The wings have a span of 60ft 3in and fold hydraulically within a breadth of 20ft. It is fitted with an arrester hook and can operate from the deck of a carrier on all naval duties except pure combat, or as a land-based general purpose aircraft. Having an all-up weight of 21,600 lb, this machine is one of the largest naval aircraft so far ordered.

Military and naval aircraft activities of the de Havilland Aircraft Company, Ltd., during the year included production of the "Vampire" and "Sea Vampire" jet-propelled machines. The last-named is similar to the well-known "Vampire" jet fighter, except that it is fitted with an arrester hook and made suitable for deck landing. This machine was claimed to be the first jet-propelled aircraft to be flown on and off a carrier deck. The take-off is illustrated in an accompanying engraving.

Finally, in referring to fighter aircraft, mention should not be omitted of the latest Gloster "Meteor IV" aircraft. It was a standard machine of this type which set up the present world speed record of 616 m.p.h. last September. This machine, of course, is fitted with twin Rolls-Royce "Derwent" gas-turbine jet units, which in standard form have each a maximum sea-level static thrust of 3500 lb at 14,600 r.p.m. This fighter and the de Havilland "Vampire," though neither of them is properly of 1946, were during the year the normal R.A.F. machine in use in many fighter squadrons.

Space considerations preclude the description in this section of several other military, naval and training types of the year. In passing, the Supermarine "Spitfire" trainer provides a much-needed high-speed fighter training machine, with accommodation for pupil and instructor; Reid and Sigrist, Ltd., produced the "Desford I," two-motor, two-seat trainer, with de Havilland "Gipsy I" four-cylinder, 130 b.h.p. engines; and the Handley Page "Hastings," the military version of the "Hermes" air-liner, was flown in prototype form. The last-named machine is a multi-purpose military aircraft, with a fuselage of large proportions throughout almost its entire length. Its *rôles* include military freighter, paratrooper, ambulance, trooper-transport, and glider tug. Airportable within it are jeeps, 25-pounder guns and 15-cwt trucks. The aircraft specification is similar to that of the "Hermes," already referred to in the first part of this article.

(To be continued)

VICKERS-ARMSTRONGS "SEAFANG" NAVAL FIGHTER BOMBER

Gas Turbine Development in 1946

No. I

THE year under review saw important developments in the design and construction of gas turbines for industrial and marine uses in Great Britain, on the Continent and in America. In our present article we seek to give as full an account as possible of the progress made by different firms; always remembering that in the early stages of such work full details of design and construction and the range of experimental work accomplished may not always be available for publication.

C. A. Parsons and Co., Ltd.

In our issue of July 19th, 1946, we gave a complete description, including sectional drawings and photographs, of the 500 h.p. experimental gas turbine unit, which was begun at the Heaton works of the Company in 1938, and is designed for a running speed of 6000 r.p.m. It works on a simple regenerative cycle using "Pool" fuel oil as the combustible. Air enters the system through a filter and then passes through an axial compressor, which delivers it at a pressure of 3½ atmospheres to the regenerator, where it takes up heat from the exhaust gases. From the regenerator, the air passes to the combustion chamber, where part of it is used to burn the fuel, and the remainder to cool the chamber walls, before it mixes with the products of combustion. The resulting high-temperature gases proceed directly to the turbine, by which the compressor is driven. A starting motor and a Froude hydraulic brake for measuring the output of the unit is provided. The plant is started up by running it up to about 3000 r.p.m. with the starting motor. Starting is facilitated by a leak-off at the tenth stage of the axial flow compressor. The fuel is turned on while the set is still being motored, and is ignited by a low-voltage arc in the combustion chamber. As the speed rises, fuel is increased and the starting motor is then automatically declutched.

Two views of the Parsons experimental set at Heaton are reproduced in the accompanying Supplement.

Throughout the past year this set, we understand, has been running more or less continuously on different grades of light and heavy fuels, in order to solve certain problems connected with the combustion process, including ash deposits in the turbine and the heat exchanger. Very little work has been done, Messrs. Parsons inform us, on the burning of the heavier oil fuels, and the programme of work on these oils, now being carried out at Heaton Works, will, it is expected, prove of particular value for commercial gas turbine units, most of which will be designed to run at a speed of 3000 r.p.m.

As outlined in our May article, C. A. Parsons and Co., Ltd., is particularly interested in the production of gas turbine units for industrial purposes, and it considers that one of the most immediately valuable outlets for this new type of prime-mover lies in its application to blast-furnace blowing, using either blast-furnace gas or coke oven gas as the fuel. In our issue of July 19th, 1946, we illustrated the layout and general arrangement of a Parsons gas turbine driven for blast-furnace blowers.

Having in view the development of such units, the firm has already prepared a number of designs, both with separate centrifugal compressors and with bled axial compressors. With its comparative freedom from cooling water requirements, and an efficiency comparable to that of a good steam plant, coupled with its moderate first cost, and its low maintenance figures, the gas turbine, in this particular field of application, may become a very attractive proposition. The success of the gas turbine depends, of course, very largely upon the type of oil fuel it can successfully burn, and the firm is, as already noted, at present concentrating its research activities on this particular question.

John Brown and Co., Ltd.

During the past year, John Brown and Co, Ltd., of Clydebank, Glasgow, has begun the construction of a 500 b.h.p. impulse gas turbine, operating on the open-cycle, the design of which has been prepared by Pametrada. Parts of this turbine were going through the shops on the occasion of our recent visit, and when the unit has been completed, in a few months' time, it will be employed primarily for experimental purposes so that blade materials and construction can be subjected to test under actual working conditions. Later on, the unit is to be installed in the works power house, where it will be employed for driving an air compressor, which will supply com-

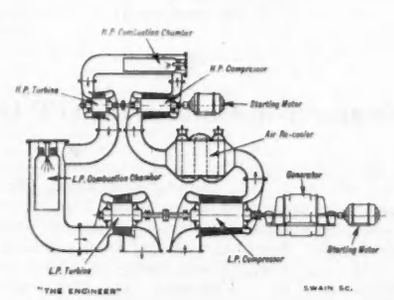
pressed air for shipyard and engine works use.

Going through the shops, we also saw parts of a 3500 b.h.p. gas turbine unit, which has been ordered for test house work at the Pametrada Research Station at Wallsend-on-Tyne. The L.P. unit and the other components are being built by ten of the other member firms of the Association.

In the year under review, John Brown and Co., Ltd., has negotiated a licence with the Escher Wyss Engineering Works Ltd., of Zurich, Switzerland, for the sole British and Empire manufacture and sale of the Ackaret-Keller (A.K.) closed-cycle gas turbine system both for land and marine purposes. In addition to long running tests carried out with the experimental unit at Zurich throughout the past year, the turbine has been prepared for, and is now being operated under, grid-supply conditions.

Pametrada Research Station

In the report of the Parsons and Marine Engineering Turbine Research and Development Association, reference to which is also made in our marine annual, evidence is given of the Association's interest in gas turbine development. One large test building is to be built for housing a series of blowers in order to provide air for the testing of turbine parts, and also to enable work to proceed on the testing of combustion chambers and heat exchangers on full scale. The test house will, it is hoped, be completed this year. The preparation by Pametrada of working drawings for a 500 b.h.p. impulse gas turbine for John Brown, and Co., Ltd., and the placing with that firm of the H.P. turbine for the 3500 b.h.p. marine gas turbine units for Pametrada, has already been mentioned. Its construction is already in progress, and is being shared by eleven member firms. This unit complete with its manœuvring and speed reduction gear, so as to enable it to work at a propeller speed of 85 r.p.m., has been designed and working drawings have been prepared by the Association. In addition, several design studies of advanced marine gas turbine installations were undertaken. A spray tester rig designed by Pametrada was put to work, and tests on a variety of oils and nozzles were made,

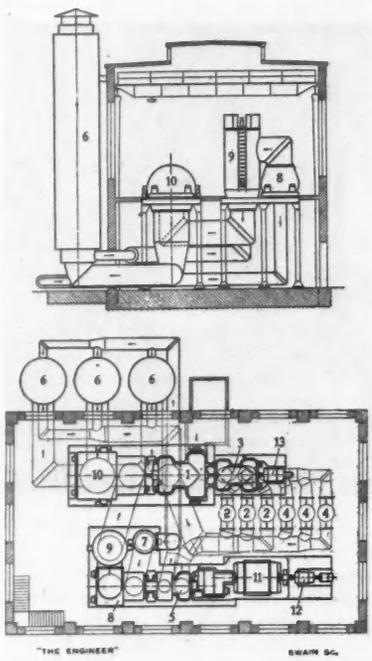


Diagrammatic Arrangement of 10,000-kW Gas Turbine

from which a considerable amount of data for gas turbine sprayers using heavy fuel oils was obtained. Close touch was maintained by the metallurgical department of the Association with the steelworks and forges which produce high temperature resisting materials, and its metallurgist collaborated in acquiring special data regarding the properties of these materials, after indicating to the steelmakers the nature of the conditions established as necessary for use in marine gas turbine design.

Brown Boveri and Co., Ltd., Baden (Switzerland)

In company with engineers from all over the world, we paid a visit to the works



1—Low-pressure compressor
2—Low-pressure cooler
3—Intermediate-pressure compressor
4—Intermediate-pressure cooler
5—High-pressure compressor
6—Air heater
7—High-pressure combustion chamber
8—High-pressure turbine
9—Low-pressure combustion chamber
10—Low-pressure turbine
11—Generator
12—Starting motor, high-pressure set
13—Starting motor, low-pressure set

Arrangement of 10,000-kW Gas Turbine

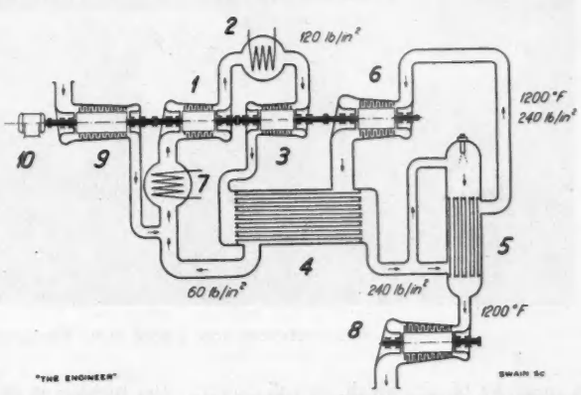
of Brown Boveri and Co., Ltd., at Baden, Switzerland, in May, last, and were able to see several gas turbines going through the shops, and on the test bed. A visit was also paid to Neuchatel to see the 4000-kW gas turbine in operation. It was started and put on to the grid in about 7 minutes. In to-day's Special Supplement, views are given of the 4000 h.p. locomotive unit, which just before the end of the year began its shop running tests. This new power plant is of especial interest as it follows the general principles of the design adopted for the 2500 h.p. unit built in 1939 for the Swiss Federal Railways, which during the past year has seen service on the French National Railways, and has made runs from Basle to Paris. The 4000 h.p. unit embodies, however, in its construction redesigned standard components along with new developments. It is built to use the same weight of air as did the former unit, and is only 3ft longer. The efficiency promises to be considerably higher than that of the first locomotive. Towards the close of 1946, it was announced that the Great Western Railway Company had placed with British Brown Boveri, Ltd., London, an order for a 2500 h.p. gas turbine electric locomotive, which will be designed and constructed in Switzerland.

At Baden, special interest centred on the 10,000-kW plant built and tested during the year for the Filaret Power Station in Rumania. It is, as the accompanying drawing and the Supplement illustration show, a two-shaft machine. It is designed for peak load and standby service, with both reheating and intercooling, but with no regenerator. We saw this unit run up to speed from standing cold in less than five minutes. It has, the tests showed, a thermal efficiency of 23 per cent, which compares well with the specified plant efficiency of 21·5 per cent with the natural gas fuel entering the system at a temperature of 600 deg. Cent., or about 1112 deg. Fah.

In the background of our Supplement illustration a further 4000-kW gas turbine plant for Peru, designed to use oil fuel, can be seen in course of erection.

Other gas turbine units on order at Baden include a 10,000-kW unit for Peru, which is of the two-stage type, designed to work with oil fuel. Three smaller gas turbine generator sets are two of 1660 kW for Venezuela, and a 1200-kW plant for Egypt, all for use with oil fuel. Another gas turbine plant for Spain, with a designed output of 1610 kW, is designed to run on blast-furnace gas and is for a Bessemer converter blower plant. The blower, which is driven by the gas turbine, supplies the air for combustion and cooling, as well as the air for the converter plant.

In May, last, two gas turbine plants, each of 4000 kW, were ordered in Baden by the Anglo-Iranian Oil Company for service in Iran. They are of the single expansion type, with no heat recuperator, and will run on natural gas. Before the end of the year an interesting order was placed with Brown Boveri for two gas turbine generating plants for a new gas turbine power station for the North East Power Company, at Beznau, Switzerland. The units are one of 13,000-kW capacity, and one of 27,000-kW



Diagrammatic Arrangement of Semi-Closed-Combustion Turbine Cycle

capacity. They are required for generating current when the hydro-electric power station belonging to the same company is reduced in output by the heavy freezing of the water supplies under winter load

conditions. They are for early delivery, and will be high-efficiency plants.

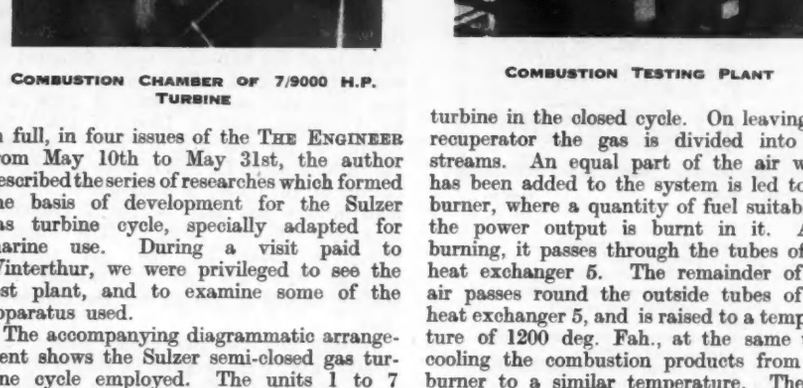
SULZER BROTHERS, LTD., WINTERTHUR, SWITZERLAND

In a paper presented to the North-East Coast Institution of Engineers and Shipbuilders, on April 5th, 1946, by Mr. James Calderwood, M.Sc., which we reprinted in full, in four issues of the THE ENGINEER from May 10th to May 31st, the author described the series of researches which formed the basis of development for the Sulzer gas turbine cycle, specially adapted for marine use. During a visit paid to Winterthur, we were privileged to see the test plant, and to examine some of the apparatus used.

COMBUSTION CHAMBER OF 7/9000 H.P. TURBINE

COMBUSTION TESTING PLANT

The accompanying diagrammatic arrangement shows the Sulzer semi-closed gas turbine cycle employed. The units 1 to 7 are, in effect, a closed cycle ; 9 is a compressor adding air to the closed cycle, and 8 is the working turbine drawing combustion gases from it. The compressor 9 draws in a quantity of air, which, at full power, is the amount required to generate the required output when, as combustion gas, it is expanded from 240 lb pressure and 1200 deg. Fah. down to atmospheric pressure. The air from the compressor is delivered into the system at a point where the exhaust air in the closed cycle is leaving the recuperator, at a pressure of 60 lb per square inch. The freshly-added air and the exhaust air are mixed, re-cooled in the cooler 7 and are then compressed in the compressor 1 to 120 lb per square inch, re-cooled in the cooler 2 and, finally, compressed in the compressor 3 to 240 lb per square inch. On leaving the compressor, the freshly-added air and the exhaust air pass through the tubes of the recuperator 4, in which they are heated to the highest temperature economically practicable by the exhaust from the turbine in the closed cycle. On leaving the recuperator the gas is divided into two streams. An equal part of the air which has been added to the system is led to the burner, where a quantity of fuel suitable to the power output is burnt in it. After burning, it passes through the tubes of the heat exchanger 5. The remainder of the air passes round the outside tubes of the heat exchanger 5, and is raised to a temperature of 1200 deg. Fah., at the same time cooling the combustion products from the burner to a similar temperature. The air in the closed part of the cycle leaving the heat exchanger 5 goes to the turbine 6 which furnishes the power required for driving the compressors. Exhausting from the turbine at 60 lb per square inch, the air is then passed through the recuperator, where it again joins the incoming air from the pre-compressor 9. The combustion products from the heat exchanger 5, at a pressure of 240 lb per square inch and a temperature of 1200 deg. Fah., are expanded in the working turbine, 8, to atmospheric pressure.



RECUPERATOR FOR 7/9000 H.P. TURBINE

In the course of his paper, Mr. Calderwood referred to the construction of a marine turbine for ship use. We are now able to illustrate the upper part of the combustion chamber with air heater of this turbine, which will operate on the Sulzer semi-closed cycle already described, and will have a designed output from 7000 to 9000 s.h.p. It is planned to run tests of the complete plant during the second half of this year.

The air heater, we are informed, has now been completely finished, and it has undergone a trial of 900 hours' duration under load conditions, corresponding in most respects to normal working. Up to the present these trials have given, we learn, every satisfaction, and no fault in the design has been revealed. This fact is of interest, as it is pointed out that the air heater unit is the only element of the gas turbine designed to operate on the Sulzer cycle, which has not already been employed in the open-cycle plants so far built. The 900 hour trial is also probably one of the longest yet to be carried out with a gas turbine combustion chamber.

In the course of the research programme, the importance of the quality of combustion was stressed, as it is very necessary to avoid deposits of residues in the air heater tubes, and at the same time to obtain a well-defined distribution of temperatures in the combustion chamber. The quality of combustion depends, it was shown, on the quality of injection and the maintenance at all times of a finely divided jet of fuel at all loads. For that reason systematic experiments were carried out in the Winterthur works with the aid of a specially constructed injection chamber. Our illustration shows an injection experiment in operation, and the flame will be seen through the window in the experimental chamber.

Several other components of the 7000–9000 s.h.p. gas turbine unit have now reached completion besides the air heater above-mentioned. We show in another illustration the tube nest of the recuperator. It will be remembered that the recuperator in the Sulzer cycle operates entirely with pure air which permits of tubes of small diameter being used, without risk of clogging. The spaces between the tubes are further reduced to a minimum by a special hydraulic process, which is employed for fixing the tubes in the end walls. With this special design, the total space requirements and the weight of the recuperator are remarkably low compared with the large heat exchange surface given.

(To be continued)

Engineer-in-Chief of the G.P.O.

IT is announced by the Postmaster-General that Mr. A. J. Gill, Deputy Engineer-in-Chief, has been appointed Engineer-in-Chief of the General Post Office, on the retirement of Colonel Sir Stanley Angwin, who has been appointed by the Government chairman of Cable and Wireless, Ltd. Following on the recent Moscow Telecommunications Conference, at which Sir Stanley Angwin headed the United Kingdom Delegation, he will, it is announced, continue to handle the work of co-ordinating the interdepartmental preparation for the forthcoming International Conference dealing with the regulation of radio. Mr. Gill, the new Engineer-in-Chief, is a Somerset man and was born in 1889. In 1925 Mr. Gill was appointed executive engineer-in-charge of the Radio Experimental Section at Dollis Hill, and in 1929 he became assistant staff engineer. Three years later Mr. Gill was appointed staff engineer of the Radio Branch of the Post Office, and in 1944 he became Deputy Engineer-in-Chief.

Metropolitan Water Board

WORKS IN PROGRESS AND CONSTRUCTED DURING 1946

Bexley.—The supply at this station is from two 24in boreholes, sunk 460ft and 450ft into the chalk. The yield from No. 1 borehole has, until recently, been upwards of 2½ m.g.d., while the test pumping from No. 2 borehole yielded about ½ m.g.d., in addition to the output from No. 1.

It is proposed to develop this station by sinking a well, approximately 6ft in diameter, to a depth of about 150ft, and by driving headings from this well to connect up to the existing boreholes.

Subject to the approval of the Ministry of Health, the tender of Le Grand, Sutcliff and Gell, Ltd., has been accepted for carrying out this work.

Chingford.—Progress on Chingford No. 2 storage reservoir, which will have a capacity of 3180 million gallons when completed, and is the last of the storage reservoirs which can be built in the Lee Valley, was seriously delayed during the war period.

About one quarter of the embankment remains to be placed as well as most of the concrete lining to the inside slopes of the embankment. The greater part of the inlet works has also to be constructed.

Progress during the year has been considerably accelerated by the use of prisoner-of-war labour. The contractors are John Mowlem and Co., Ltd.

Cricklewood.—This station repumps water received from Kempton Park works into several zones of supply. The pumping plant consists of three triple-expansion engines and pumps, three diesel engines and pumps, and one electrically-driven booster pump, installed in the years 1908, 1914, and 1939, respectively.

The steam plant, which has been worked almost continuously since 1908, is now in need of repair, but the load is such that it is impossible to lay by an engine to gain sufficient time for this purpose.

A complete reconstruction scheme is contemplated for this station in the near future, but, in the meantime in order to enable the steam plant to be overhauled, three vertical spindle electrically-driven, centrifugal pumps, suitable for 10 m.g.d., 5 m.g.d., and 5 m.g.d. are to be installed.

Subject to approval by the Ministry of Health, the tender of the Harland Engineering Company, Ltd., has been accepted for supplying and erecting these three pumps.

Cricklewood is also one of the Board's principal stores depots, and this is being extended.

Dartford.—The supply at Dartford pumping station is 1 m.g.d., obtained from an existing shallow well continued into the chalk as a 24in borehole to a total depth of 250ft.

The pumping plant, which comprised a horizontal compound steam engine (installed in 1902), working a reciprocating bucket pump and a force pump of the ram type, has been replaced by electrical pumping plant, operated by purchased current with a diesel driven alternator as a standby.

The new plant comprises an electrically-driven borehole pump, which has been supplied by Hathorn Davey and Co., Ltd., to deliver 1 m.g.d. from 60ft below ground into a contact tank, and a motor-driven force pump to deliver the water from the contact tank into supply. The machinery was supplied by George Cohen and Sons, Ltd.

All the plant has been erected and trial runs have taken place.

Hammersmith.—This station pumps water received from Barnes and Barn Elms filtration stations into several zones of supply. The normal duty is about 30 m.g.d.

Two electrically-driven horizontal centrifugal pumps operated by purchased electricity have been installed in an existing building to replace two Cornish beam engines, put to work in 1855 and 1863. One of the pumps is of 8 m.g.d. capacity, against 195ft head and the other is of 5 m.g.d. capacity, against the same head. A considerable saving in coal consumption is effected as well as of running costs. The pumps were supplied by Worthington Simpson, Ltd. The contractors for the necesary structural alterations were Grace and Marsh, Ltd.

Hampton.—These works date from 1852, and are the largest operated by the Board.

At this station, Thames-derived water is filtered and pumped into supply.

Shortly before the war a large scheme of remodelling, comprising mainly new machinery and the installation of primary filters, was commenced, and this is designed to increase the capacity of the station from about 55 m.g.d. to 120 m.g.d.

The new engine house was finished and the machinery in it set to work before the outbreak of war, but the remainder of the scheme was seriously delayed during the war period.

The primary filters have been completed, as well as the major part of the laying of the new conduits and mains necessary for incorporating the new works into the existing station.

The construction of the 11·3 million gallon balancing and contact reservoir and the erection of the screening apparatus is nearing completion. The contractors for the reservoir are William Moss and Sons, Ltd. The screening apparatus is being supplied by Guest and Chrimes, Ltd.

The contract for the manufacture of the pumping machinery for a new raw water pumping station at Sunnyside to enable water to be abstracted from the river at that point, has been placed with W. H. Allen, Sons and Co., Ltd. The building work—for which the contractors are F. R. Hipperson and Son, Ltd.—will be commenced early in the new year.

Work is in progress on the construction of 1000 yards of a 54in raw water conduit for increasing the supply of raw water from Queen Mary and Staines reservoirs to the primary filters. The conduit is of welded steel shells ⅜in thick (⅝in on bends), surrounded with concrete and lined with 2in of cement mortar applied with a cement gun.

The contractors for the supply of the steel shells are Horseley Bridge and Thomas Piggott, Ltd., and the contractors for the construction of the conduit are William Moss and Sons, Ltd.

Hornsey Lane.—The repairs to the service reservoir which has a capacity of 3 million gallons and which had been found to leak badly, were completed. The removal of the existing stone slabs and layer of clay puddle overlying the old concrete floor and the resurfacing of the latter, were done under the pipelaying contract, and by direct administration. The guniting of the walls and floor to form a waterproof lining was done by William Moss and Sons, Ltd. J. B. Edwards and Co. (Whyteleafe), Ltd., were the contractors for surfacing the roof with ¾in of asphalt and replacing the soil covering.

Kempton Park.—At this station, Thames-derived water is filtered and pumped into supply. The normal duty is about 36 m.g.d.

As the existing steam raising plant, some of which is 43 years old, is severely taxed owing to the increased load, two additional water-tube boilers of a nominal capacity of 60,000 lb per hour are to be installed. The contractors for these are John Thompson (Water Tube Boilers), Ltd. To maintain the supply until the new steam raising plant is in commission, two electrically-driven A.R.P. pumps are being used.

The tenders of the Candy Filter Company, Ltd., and of the Paterson Engineering Company, Ltd., have been accepted for the construction of two experimental purification plants, each of a nominal capacity of 1 m.g.d. The chief advantage of locating this experimental plant at Kempton Park is that unfiltered water from several storage reservoirs as well as raw Thames water will be available.

In addition it is proposed to instal four rotary strainers for experimental purposes, to work in parallel with the existing primary filters. Subject to the approval of the Ministry of Health, the tender of Glenfield and Kennedy, Ltd., has been accepted for the supply and erection of these rotary strainers.

Lee Bridge.—River Lee water is filtered and pumped into supply at this station, which has a normal load of about 40 m.g.d.

Due to the pressing need for proceeding with the design and construction of other major works, especially new filtration plant to provide an increase in the total supply, it has been decided to postpone for some years the replacing of the Lee Bridge works by a new station, and to proceed with an interim scheme of reconstruction to last until the new works are constructed. The interim scheme provides for the installation of electrically-driven pumping plant driven by purchased electricity and installed in a temporary engine house, with standby diesel driven alternators. A contact reservoir, having a capacity of 3 million gallons, and filled by low-lift electrically-operated pumping plant, together with the necessary mains and connections, is also under construction as part of the scheme.

Work has commenced on the manufacture of eight d.c. electrically-driven low-lift pumps by Hathorn Davey and Co., Ltd.

The contractors for the electrical motors, switchgear and other pumping machinery are the Harland Engineering Company, Ltd., the Electric Construction Company, Ltd., and W. H. Allen, Sons and Co., Ltd.

The concrete foundations for the pressed steel plate contact reservoir have been constructed by direct administration and the plates for the reservoir are being supplied and erected by Braithwate and Co., Engineers, Ltd.

The mainlaying is being carried out by William Press and Son.

North Orpington.—This is a new station, at which there is a 24in borehole, 350ft deep; the water from which augments the supply to the Kent area.

Electrical pumping plant has been installed, comprising an electrically-driven borehole pump of 1 m.g.d. capacity, supplied by Hathorn Davey and Co., Ltd., surface and booster pumps supplied by the Pulsometer Engineering Company, Ltd., and motors supplied by Geo. Cohen, Sons and Co., Ltd., and W. H. Sugden and Co., Ltd.

The contractors for the building were Grace and Marsh, Ltd., and the 12in and 18in delivery mains were laid by J. B. Edwards and Co. (Whyteleafe), Ltd.

This station is now pumping into supply.

Staines.—Progress on Staines No. 2 storage reservoir, which will have a capacity of about 4400 million gallons when completed, and will be a valuable addition to the total available storage in the Thames Valley, was seriously delayed during the war period.

Progress during the year has been accelerated by the use of prisoner-of-war labour.

Apart from a small amount of the concrete lining slabs to the inside slopes of the embankment which remains to be done, the reservoir is completed. The contractors for this reservoir are John Mowlem and Co., Ltd.

Surbiton.—At these works where Thames-derived water is filtered and pumped into supply, and which has a normal load of 36 m.g.d., the reconstruction of the slow sand filter beds has been continued. Filter bed No. 10 has been completed and set to work. A start has been made with the reconstruction of filter beds Nos. 5 and 11. The work is being undertaken by direct administration.

General.—Additional electrically-driven pumping plant has also been installed at a number of other works.

The chemical treatment plant at several stations has been improved and modernised. In order to provide time for the chlorine to remain in contact with the water before it is pumped into supply, the Board has decided to incorporate contact tanks in its filtration and well stations. A number of these have been constructed at the latter in carrying out this policy.

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A Retrospect

THREE days ago there was a change of one digit in the date. Nothing else of world-shaking consequence happened. There was not, there could not be, any change in the continuity of events. Yet engineers even more than other men welcomed the coming of the New Year and the passing of 1946 with relief. For if ever the events of a year seemed to juniors, executives and directors "a tale told by an idiot, full of sound and fury, signifying nothing," it was those of 1946. Yet the year began in an atmosphere of high confident hope. The war was well over. Engineers could turn away from the manufacture of weapons of war and the means of destruction. They could now look forward to reconstruction and the further building up of material prosperity, which is their true function and upon which modern civilisation depends. A beginning could be made at last to breathe life into those many plans for a better Britain, which had engaged their attention even while the bombs were still falling and the guns still thundered. In the "first fine careless rapture" of relief from war the country was in an optimistic mood. Already skilled men were returning from the Armed Forces, eager to make those peacetime goods that had so long been lacking. Soon there would be more food to eat, more clothes to wear, more goods to buy. Travelling would be easier, hours of work less, homes warmer. Engineers, striving to reconvert factories to peacetime work and to apply the productive lessons of war to the manufacturing arts of peace, looked forward, too, to the work of supplying the country and, indeed, the world with British products. How have all these high hopes seemed to fall! In January shortages of manpower and of raw materials, difficulties of transport, the necessity of filling innumerable forms before anything could be done, labour difficulties, the lack of skilled hands and all the rest, seemed natural and bearable. The war was barely over. But, providing the new Labour Government put no spoke in the wheel, the enterprise of engineers would soon start putting matters right. A few months should see such troubles well on the road to cure. But to find in December the same troubles still with us was maddening in the extreme! To find the erection of the new factory or the new wing well behind programme because the Government seemed to give undue prominence to the housing programme; to continue to experience delays in the receipt of raw materials; to have the output programme upset by unexpected cuts in the allocation of steel and other materials; to find castings often unprocurable and coal supplies inadequate; to be still filling up innumerable forms and experiencing aggravating delays due to the dilatoriness of Government Departments; to experience transport delays and undue losses, theft and breakage in transit; the find the output per man-hour of workers down though wages had risen and hours of work been reduced; and, finally, to experience upon the top of all such troubles constantly reiterated exhortations by politicians that production must be raised! To what end did engineers struggle if every effort ended in frustration?

In truth the optimism of the opening months of the year, fed and maintained, as it was, by the encouragement of export figures mounting rapidly towards the export target and promising to reach it far earlier than could reasonably be expected, was wholly false. Only as the year began to draw to its close did the real magnitudes of the problems facing the country at home and abroad make themselves apparent. In the spring we said glibly that, of course, the attainment of the export target, the raising of more coal, increasing the output of industry and the attainment of at least our pre-war standard of living was going to be difficult. But it was only as summer sank into autumn that we began to realise just how really difficult it was going to prove to do those things and just how long it was going to take. For the very activity that brought about a rapid revival of peacetime production in the opening months of the year bred new shortages towards its close. It was not, by pre-war standards, shortage of electricity that led to daily cuts in power. Demand rose from nearly 25,000 million units in 1938 to something over 40,000 million units in 1946! Steel output to-day of the British industry stands at a level higher than it has ever reached before in peace at a rate of more than one million tons per month. The amount of coal leaving the mines would in 1938 have been ample to meet all home demands and a considerable proportion of export requirements as well. Nor is the labour force, exclusive of men still in the Armed Forces, smaller, though its distribution may be maladjusted and its output less satisfying. Maybe the story of reconversion to peacetime plenty must follow the same course as that of armament for war. Was it not Churchill who said of production of munitions by a country unprepared for war "in the first year, nothing; in the second year, very little; in the third year, nearly enough; in the fourth year, all you want"? The recovery of peacetime prosperity may well take quite as long. For he would be an unwise optimist who foresaw at an earlier date than 1950 an ample supply to meet enhanced demands for electricity, coal and steel—the power, fuel and raw materials for industrial activity.

But we suspect that those who struggled through 1946, endeavouring to make the best of a trying situation, are hardly the best judges of their real achievement. What will a historian, looking back from twenty or thirty years on, make of their labours? Certainly the year will seem to him "full of sound and fury." But will he, seeing it as a whole, find it "a tale told by an idiot, . . . signifying nothing"? We doubt it. Indeed we think the year's work signified very much. It was a remarkable recovery to raise the export figure to 120 per cent by volume of 1938 by July. It was a great achievement, hindered, as it was, by Government proposals for nationalising the industry, to be producing and using over one million tons of steel a month for peacetime produce, scarcely a year after the end of the war. Despite difficulties and setbacks, despite hindrances and delays imposed by unnecessary nationalisation proposals, despite frustration of every kind, engineers did bring about a remarkably rapid reconversion. To deny it would be to indulge in our national weakness for exaggerated self-criticism. We may take heart from the words of one in another land which is struggling with difficulties of reconstruction heavier in some respects than our own. The great Monnet plan for France praises this country for its energy and self-restraint: "Great Britain has emerged from this war with her industrial equipment improved, while ours is in bad condition. Yet Britain accords so high a degree of priority to the needs of exports and re-equipment that consumption there is subject to more restrictions than during the War." To those concerned with the details of reconstruction much may seem confused and disorderly. But many countries in the world are watching Britain's efforts to recover with respect not unmixed with admiration.

NATIONALISATION

It is a point particularly worthy of notice when Socialists in Parliament and outside are so fond of decrying the merits and criticising the efficiency of private enterprise, that the rapid recovery from war, the speedy reconversion of works for peacetime productivity and the boosting of exports within twelve months of the end of the war to levels above those ruling in 1938 was almost entirely the work of just that form of business. It is certainly true that the Government and the Civil Service did much to aid the recovery. They gave advice and assistance to exporting firms, gave encouragement to research and development, provided information as to means of economising fuel, allotted materials in short supply in accordance with priority of need—a task which laid the Government

Departments concerned open to much criticism—and endeavoured to increase the supply of alternative materials. But the Government also did much that was far less beneficial. It is certainly pertinent to ask whether at a time when a nation is struggling to recover from the effects of war is the very best of periods in which to bring forward controversial Socialistic measures for nationalisation. Had the Government confined itself to the nationalisation of the Bank of England and of the coal mines there would be little cause for real complaint. For since the Treasury and the Bank had for very many years worked hand in glove together, the former measure caused very little real change; whilst nationalisation of the mines, regrettable though it might be on other grounds, seemed the sole means by which labour unrest could be avoided in an industry distracted by such troubles between the wars. But, in fact, the Government went much further. In particular the threat of nationalisation that hung so long over the iron and steel industry inevitably imposed delays upon the execution of the great scheme of reconstruction planned by its Federation, at the very period when prospective demand for its products was so high that undisturbed continuity of work was urgently necessary. Nor was that uncertainty wholly allayed by the appointment of an Iron and Steel Board. Before members of sufficient eminence could be persuaded to sit upon that Board the requirement that it should advise the Minister about the definition of those sections of the industry that were to be nationalised had to be deleted. But the Government, in the person of Mr. Morrison, has, since the appointment of the Board, continued to reiterate the intention at some unspecified time to bring the industry under some form of public ownership. Uncertainty thus still flourishes.

Of certain other nationalisation measures we have not space to write. But in the last month of the year the Government presented a nationalisation Bill more contentious than all the rest. Can it really be pretended that the passing of the Transport Bill is likely to assist the recovery of the country? It would be absurd to deny that there are arguments for nationalisation. Long before the war nationalisation was considered as a possible solution of road-rail difficulties. It still remains a possible solution, though in our view its disadvantages outweigh its merits. But is the present an opportune moment to undertake the work? For if the Bill becomes law the whole distribution system of the country must in some degree be upset for several years by the resulting reorganisation. Moreover, much attention of many businesses that ought to be concentrated on means and methods of increasing production must now be diverted to consideration of the impending effects of the Bill and the provision of ammunition for those who—rightly in our opinion—are opposing the scheme as ill-advised, inopportune and ill-adapted even to carry out the very purposes for which it is designed. Nor is the Transport Bill the last of such proposals. At the opening of Parliament in November the King's Speech clearly indicated that the days of independent electricity supply companies are numbered. Private gas companies will no doubt follow them into the nationalisation fold, and no one knows what further proposals are to be brought forward. Is such a condition of doubt an encouragement to hard work and initiative?

Manpower

The year was unusually consistent in that few of those questions that troubled men's minds at its beginning were not still matters of serious debate towards its close. The reason, no doubt, lay in the fact that the key to the year was set by an economic condition. If this country is to pay for its essential imports, to repay debts to the sterling area and to repay the loan granted by America, with its promise that the sterling "bloc" be liquidated this year, it was early made clear that exports would have to be raised as rapidly as possible to 75 per cent by volume above the figures for 1938. That necessity required the diversion of a larger proportion of our available labour to export work than was needed in 1938. Further, in a disturbed world it was thought essential to maintain larger Armed Forces in the service of the Crown. Moreover, there was, in addition to ordinary production of "consumption" goods for the home market, an urgent need to repair war damage, to re-equip industry and to make up arrears of maintenance in all kinds of plant. In the result it became more and more obvious as demobilisation continued and industrial plants were reconverted for peactime productivity that the country was seriously short of manpower. More particularly the effects became apparent, in the absence of direction of labour, in the coal mines and the foundries, both of which proved to be unattractive trades. But all industries experienced the effects of the shortage in some degree, and if, as seems rather likely, the shortage persists over a term of many years to come, it must have profound effects upon productive methods and upon the relations between employers and wage-earners.

Labour and Production

The least satisfactory feature of the year was the attitude of labour collectively in the unions and individually in the shops. The over-riding need when manpower is short is for hard work so that production can be kept up. Yet the unions chose 1946 in which to press strongly for the adoption of the forty-hour week, for increases in rates of pay and for holidays with pay. No arguments that shorter hours must inevitably reduce production or that making up the lost hours by working overtime was equivalent to an increase in wages and must thus force up prices availed, and in several industries a shorter working week was adopted. In engineering, as from the first day of the New Year, hours are forty-four, spread in general over a five-day week. What the effect upon prices and upon output will be remains to be seen. Indeed, the full effect may not become apparent until the seller's market throughout the world breaks and the country has to attempt to maintain exports at a very high level in the face of international competition. No doubt union leaders are well aware that increases of wages, of which many were granted during the year in many trades, are useless as a means of raising the standard of living unless accompanied by increased output as a result of harder work or improved methods of production. But that fact was no better appreciated by the rank and file during 1946 than in any previous year. Quite early in the year many employers were voicing the complaint that there was a drop in output per man-hour of the workers as compared with the days before the war, and the complaint became more general as the months passed by. There is no doubt at all that a minority of workers took advantage of the ease of finding alternative employment to press forward unreasonable demands and to do far less work than they were really capable of doing. That explanation of reduced output hardly seems tenable, however, for the great bulk of labour and many other supposed explanations were put forward, such as a monotonous and barely sufficient diet, war-weariness (whatever precisely that may be taken to mean), lack of incentive when there is little to buy in the shops, the effects of income tax P.A.Y.E., particularly on overtime working, dis-organisation due to the change-over of working forces in factories, the effect of a guaranteed week, that general frustration following upon controls and shortages from which we are all suffering, or lack of fear of the "sack." Whatever the cause, the consequences may well prove serious if output per man-hour does not soon show improvement in 1947.

It would, however, be false to give the impression that the year was wholly unsatisfactory on the labour side. It was, for instance, unusually free of strikes, and the bulk of those that occurred were sectional and undertaken in defiance of union advice, a fact that suggested that some improvement of union internal machinery was necessary in order that local grievances could rapidly be set right. Moreover, to judge by the President's Address to the T.U.C. in October, the union leaders, at least, appreciate that under the conditions of "full employment" which the country is likely to enjoy for some years to come the attitude of labour must change in relation to productivity, and in particular many of those restrictive practices upon output that were adopted in the mistaken impression that they maintained a high level of employment may need re-examination. It is to be hoped that such opinions will rapidly filter down to the lower grades of the trade union hierarchy.

The "Closed Shop"

The "closed shop" became an issue towards the end of the year, following upon an agreement between the L.P.T. Board and the Transport and General Workers' Union that no other union should be recognised for road transport operators. The distinctive character of this agreement was not the fact that employees were required to join a union, but that the union they were to join was specified. Freedom of choice was refused. The issue thus raised clearly affects closely the rights and the personal liberty of individuals. It is more fully discussed on another page.

Coal

The shortage of coal bulked so large as a factor in the history of the year that it would be impossible not to refer to it here. Yet in reality there is not very much that can be said about it. There seems little likelihood of any considerable improvement of output

until more workers can be attracted to the industry or greater mechanisation and improved organisational efficiency can be attained, both long-term rather than short-term possibilities. It is a remarkable fact that in a country as rich as Britain in coal measures the whole economy of the country should be seriously threatened by shortage. Stocks at this time of the year have not been so low in this country for very many years, and should January and February prove as cold as the middle of December, it may well be that the work of industry may be interrupted owing to lack of fuel. Even in December the threat had become imminent. Though manpower in the coal mining industry was still slightly declining towards the end of the year, output per shift per man was beginning to show some improvement. It remains to be seen whether that improvement will continue and whether the Coal Board, which took over control of the mines on January 1st, will be able to attract new entrants to the industry, raise output and reduce costs. The lack of a surplus of coal to export is seriously disturbing the country's power to obtain imports of sadly needed other raw materials.

Gas Turbines

The jet propulsion gas turbine engine was developed as a war weapon. But it became apparent during 1946 that very many if not all British aircraft of the near future will be propelled either by jets alone or by a combination of jets and propellers driven by gas turbines. For the jet not only has the advantage over the propeller for high-speed flight. It is also very much quieter for passengers in the aircraft and the turbine gives rise to far less vibration than the piston engine. These advantages were proved during the year by a "Lancastrian" fitted with two piston engine-driven propellers and two jet engines. Moreover, whereas the piston engine has been developed so far that there is little room for further improvement, gas turbine design is in its early stages and still open, no doubt, to very considerable further development. In experience with and in knowledge of practical design, British engine builders, thanks to the pioneer work of Commodore Whittle, gained a lead over the whole of the rest of the world. That lead was maintained and consolidated during 1946.

But a more important application of the gas turbine unquestionably lies in industry and the qualities required in an industrial gas turbine are very different from those essential for aircraft propulsion. Some at least of the knowledge gained from the construction and use of aircraft gas turbines is no doubt applicable to the industrial variety. But there remain many new problems to solve. In practical experience with the industrial gas turbine the Swiss have the advantage over every other nation, as they have had a number of plants operating since long before the war and have since built others. It is natural, then, that manufacturing firms in this country should turn to them for advice. Yet it is encouraging to find that at least one British firm proved sufficiently confident of the ability of its own designers to erect an experimental plant with which to build up its own experience during 1946. If British scientists and technicians were able to solve the problems of jet propulsion during the war, what reason is there to suppose that we must now depend upon foreign assistance in the development of practical and successful industrial gas turbines?

Atomic Energy

Great interest continued to be excited in 1946 by everything that was published about atomic energy. Atom bomb tests were carried out at Bikini by the United States Navy in July; efforts were made throughout the year by the United Nations to reach agreement about the control of atomic energy for destructive purposes; and discussion of the possibilities of applying nuclear fission beneficially for the production of electrical power and for other useful purposes, of course, continued. But little reliable information became available as to the real practical and economic possibilities.

Although secrecy prevails regarding many aspects of the results obtained at Bikini, the general impression gathered by unofficial observers seems to encourage the view that at present the atomic bomb is not quite such a deadly weapon against naval vessels as might be supposed. Nothing emerged to justify any belittlement of its great power of destruction of thickly populated areas on land. Against ships at sea, however, it would appear that dispersal will prove a good defence. So far as the effects of blast and scorching are concerned, a distance of about a mile from the centre of the explosion would seem to be sufficient to ensure against major damage. The greater danger lies in the induced radio activity which accompanies the explosion. It is not known publicly to what range this danger extends or how long after the explosion it persists, but it does not seem to be impossible that precautions against it may be devised. As regards the use of nuclear fission for power production, it would appear that at present the prospects are not over good. The fact seems to be that with the methods at present available there is not enough uranium and thorium to replace more than a minute proportion of the coal and water power annually consumed in the world for power production purposes. Progress in this field, it is to be inferred, will be limited until either new fissile substances are discovered or until physicists learn how to make use of the materials at present in use with greatly improved economy, as it seems very probable they will.

The efforts made during the year by the United Nations to reach an agreement on the control of atomic energy achieved no definite result, although towards the end of the year signs appeared that some kind of solution might yet be hammered out. The problem is a difficult one. International jealousy and distrust play a large part in it, and on the purely technical side it is not easy to devise any scheme which will permit nuclear fission to be applied usefully for peaceful purposes without creating a potentiality for the production of atomic bombs either surreptitiously or quickly after a declaration of war. We feel tempted to wonder, rather desperately, whether as a last resort the most satisfactory solution will not be found to lie in allowing all nations to arm themselves with an agreed number of atomic bombs. The knowledge that no one nation was better placed than another might effectively prevent the use of the bombs in war. In the late war, neither side used poison gas, although, as we now know, both were ready and able to do so. Even in the last desperate days, Germany refrained from employing the deadly new gases which she had developed because her rulers knew that equally deadly gases would immediately be used against her. May it not be the same with the atom bomb?

Conclusion

This article is entitled "A Retrospect," a looking back towards the past. Yet it is impossible to look back over the events of 1946 without having one's thoughts thrust forward to the future. So many coming events throw their shadows before them. The year posed questions. It did not answer them. Will world trade expand? What will be the effect on international economics of the Republican victory in the U.S. Congressional elections? Shall we be able to reach the export target that has been set for us? Those are economic questions. What will be the effect upon export prices of shorter hours of work and higher rates of pay? How will our prices compare with those of other nations when the sellers' market collapses? Will the output of labour per man-hour recover? Will trades unions forgo restrictive practices and encourage the development of new and improved methods of production? Those are questions for business men. How soon will our standard of living improve? What effects upon the performance of labour will security of employment prove to have? How can labour be brought in to unattractive industries? Those are human questions. Lastly and formidably; What is going to be the effect upon the world of the utilisation of atomic energy, and how soon and in what form, beneficial or destructive, are we next to see it manifested? That is an economic, a technical and also a very human question. Not all such questions originated in 1946. But every one of them, and many more, were vital living issues troubling and exciting the minds of men. Nor were such questionings confined to this land alone. Shortages of food and coal and steel and power are worldwide, not confined to Britain. Other lands need to increase their exports, and workers elsewhere than in this country seem disinclined to work as hard as they used before the war. Man as a whole shudders under the threat of the ills that knowledge of atomic energy might bring. Yet we look hopefully forward. In the year 1946 man tried once more to turn his back upon the past and to begin to lay foundations for the future. He set out again, as he has set out so often unsuccessfully in the past,

> "To build a new life on a ruined life,
> To make the future fairer than the past
> And make the past appear a troubled dream."

Will he, under the threat of destruction if he misuses his control of Nature, at last succeed?

Tin in Burma and Malaya.—The Ministry of Supply has announced that its Malayan Tin Ore Buying Agency (Toba) ceased to purchase tin concentrates in Malaya on December 31, 1946, and that its tin agent in Lower Burma, Mr. A. P. Ruddy, has ceased to buy tin concentrates there. Producers are now free to sell concentrates to the smelters. The Ministry will, however, continue to buy all the tin metal produced by the smelters in Malaya.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

LOCOMOTIVE BOILER PRESSURE

SIR,—I have read with interest W. A. Tuplin's discourse on Locomotive Boiler Pressure. Under the heading "High Boiler Pressure"—last paragraph—the statement that "no appreciable lightening of moving parts is possible," is rather misleading—in fact, this is not borne out in practice.

Lightening of moving parts—piston and rod, connecting and coupling rods and valve gear by the introduction of special steels and roller bearings is accepted practice in America. One of the finest examples of light-weight motion in practice may be observed on the Pennsylvania railroad system, a practice which has been rigidly followed for the last 36 years.

An example of weight-saving in moving parts is tabulated below, and was supplied by The Timken Roller Bearing Company, of Canton, Ohio, to a well-known railway company of America.

	Bearings	
	Plain lbs	Timken lbs
Crosshead assembly	754	367
Piston, piston rod and parts ...	765	350
Front end of main rod	422	210
Union link and bushing	30	17
Total	1,971	944
Per cent	100	48

The results show a saving of 52 per cent in reciprocating weights, which likewise lightens the resultant hammer blow on the rails.

With these bearings and rods, the following advantages are shown, all of which aggregate to a saving in operating costs.

(1) Increased locomotive availability, as against normal bearing locomotives, to as much as 75 per cent.

(2) Trouble-free operation by the elimination of hot boxes, liners and other forms of journal trouble.

(3) Reduction of maintenance and inspection on account of item (2).

(4) Reduction in lubrication—a day's supply of oil for the normal bearing locomotive being sufficient for at least 30 days on a roller bearing locomotive—furthermore, special oil is not necessary, just regular valve oil may be used.

(5) Reduction of maintenance costs, due to items enumerated above—showing as much as £1000 per annum per locomotive.

(6) Increased draw bar pull is effected by the reduction in journal resistance.

SELECTION OF WORKING PRESSURE

In America, rather than avoid higher boiler pressures, the tendency is the other way—coupled with a decrease in cylinder bore and long stroke. Valve travels on the other hand are increasing from 7in to 9in. with laps and leads of $1\frac{3}{8}$in to $2\frac{1}{4}$in and $\frac{1}{4}$in to $\frac{3}{8}$in, respectively.

Boiler weights in respect of high pressure boilers need not be so excessive, nor need maintenance costs tend to rise when using some of the new steel alloys, to wit—nickel steel, silicon, manganese, &c.

Whilst these facts are based on new construction there is no reason why they should not be applied to rebuilds, admitting that costs are slightly higher in the first place, but are offset by lower operating and maintenance costs.

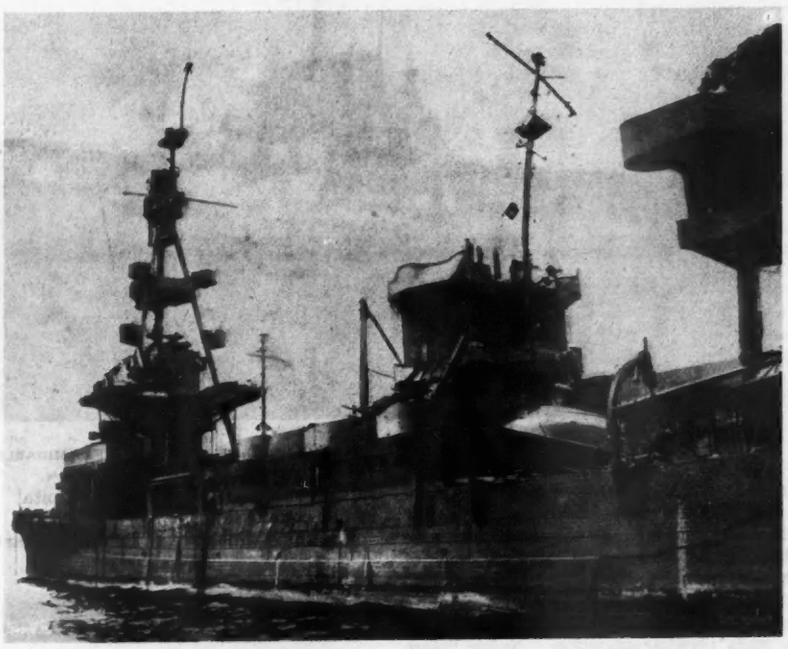
ARTHUR H. GRAHAM.

London, S.W 11,
December 28th, 1946.

Naval Replacement

(By Our Naval Correspondent)

THE year 1946 will probably be accounted the most significant in the history and future of all navies. At the end of every war there is a period of transition in naval affairs, and with it a form of stocktaking, with particular reference to the experiences of the war and to the development of weapons of offence and defence. To-day, transition and stocktaking are to a very great degree overshadowed by the atomic bomb experiments held during the summer in the lagoon at Bikini.



U.S. CRUISER "SALT LAKE CITY" DAMAGED AT BIKINI

It is as yet too early to draw firm concluclusions from those tests, the more so because yet another test is planned for the coming year. The British Admiralty is at present considering the lengthy report of the tests brought back by its official observer, Captain S. W. Roskill. When this has received the study which it merits by the various divisions of the Naval Staff, the whole question of the future of naval and other armaments in face of the new factor of atomic warfare will presumably be investigated by a committee of experts. This is likely to be the first major task of the new Ministry of Defence.

The task of examining the evidence, forming conclusions, and making recommendations for the future of the armed forces obviously carries with it a tremendous weight of long-term responsibility. One cannot therefore expect rapid decisions. Yet decisions are urgently needed, and particularly with regard to the navy. There is not the slightest doubt that the present uncertainty about the future is injurious

U.S. SUBMARINE "SKATE"

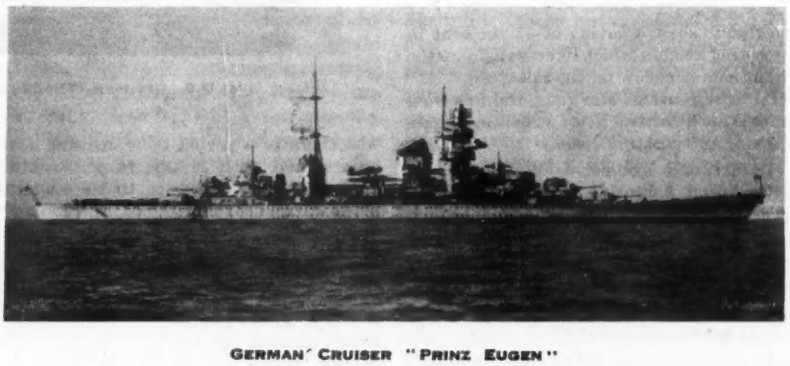
to a great Service. This is not solely because of its effect upon officers and men. It concerns also the naval material. If our naval strength is not to be found inadequate to its probable responsibilities in a few years time, it is necessary to authorise without delay the laying of the keels of vessels to replace ships which have been virtually worn out by war service.

H.M. AIRCRAFT CARRIER "FORMIDABLE"

At the present time the Royal Navy is in a most peculiar situation. Never before in modern times have so few ships been in full commission and fit to undertake operations. The Home Fleet, the Mediterranean Fleet, and the few squadrons in the east are only token forces. So far as the major units of the fleet are concerned —battleships and aircraft carriers—the navy of to-day is training, trooping, or in reserve. It was stated officially in Parliament the other day that the Royal Navy's battleship strength would be reduced by December 31st to two ships in active commission, while three other battleships with specially reduced complements would be employed as harbour training ships, while four battleships and one battlecruiser would be retained in reserve.

As H.M.S. "Vanguard" will be detached for special duty in connection with the Royal Tour to South Africa, this means that the operative fleets of the British Empire will among them muster one capital ship in full commission.

The ships which are to be used as harbour training ships or kept in reserve cannot, moreover, be regarded as an "operational reserve." With the exception of the three ships of the "King George V" class and H.M.S. "Nelson," all are of pre-Jutland design and have already outlived their useful lives. It is, for instance, now eight years since the Admiralty announced that it was the policy to scrap the ships of the "Royal Sovereign" class as the replacements (the ships of the "King George V" class) became available.

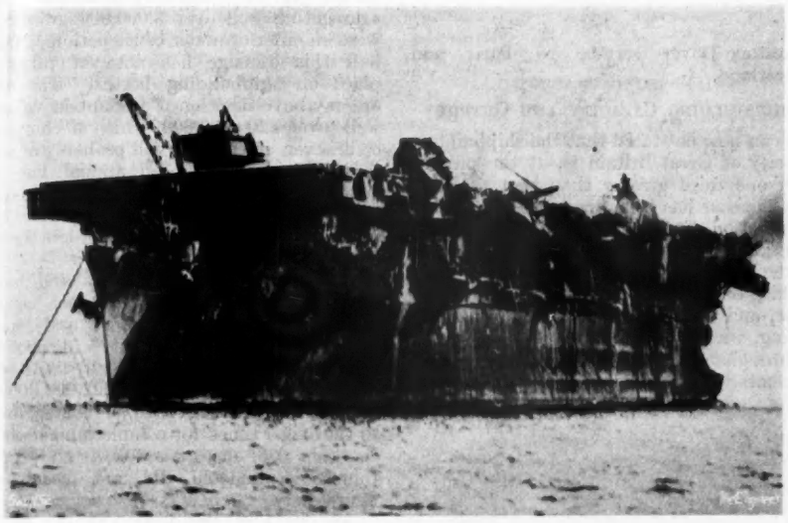


GERMAN CRUISER "PRINZ EUGEN"

It is, of course, obvious that the aircraft carrier has taken the place of the battle-

U.S. SUBMARINE "SKATE" DAMAGED AT BIKINI

ship as the most important unit of the modern fleet. The position, however, is not much better with regard to the big "fleet" carriers. Attention has been drawn to this fact by the statement that H.M.S. "Formidable" is to be placed in reserve in the near future, and that this is to be done without repairs being done to her flight deck, which was damaged by Japanese suicide aircraft. The reason given for not repairing this deck is that the money required is not available at the present time. It means, however, that the "reserve" cannot be considered at its face value, since it will contain ships which are not fully efficient. In aircraft carriers of the "light fleet" type there are, however, some replacements coming forward. Ships which were nearing completion at contractors' yards have been towed away to the Royal dockyards for completion, thus freeing berths in the contractors' yards for commercial work.



U.S. AIRCRAFT CARRIER "INDEPENDENCE"

In cruisers and destroyers the reserve is now much bigger than the active fleet. This is inevitable at the present time, but the Admiralty and the country must remember one of the major lessons of the war—the essential requirement of a shipbuilding and engineering industry capable of rapid expansion in the face of all difficulties. It is doubtful whether the industries would be capable of answering to the full the sudden emergency calls of war if they were denied the fairly regular building of warship types in peace.

The shortage of ships and the need to replace many worn out units, particularly in the largest category, is one side of the picture presented by this year of dilemma. The other side of the picture is : if it is decided to build warships, what types shall we build ?

The answer to that question obviously lies in the full examination of all the evidence produced at Bikini. It is, however, questionable whether it is not dangerous to await the full findings from these experiments, which may not be available for a year or more now that it has been decided to carry out further trials. If the findings are delayed, as seems probable, to await them before laying a single keel will be to ensure a most dangerously lean time for the navy in some years to come.

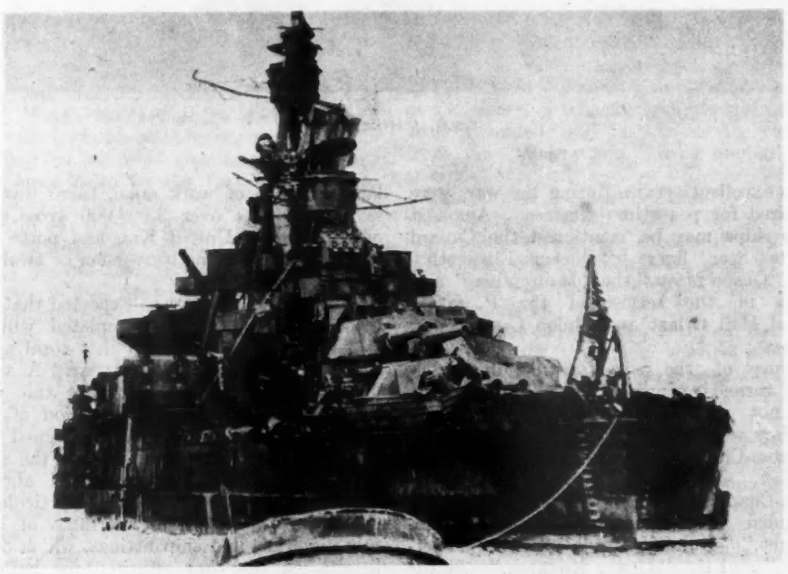
One or two points were so evident during the Bikini atomic bomb trials that they can be outlined without awaiting the full reports. The outstanding point was that the experts were, on the whole, slightly disappointed at the effects of the atomic bomb, and particularly with the effects of the first test in which the bomb was exploded in the air above the target area. Ships were certainly sunk and other ships were certainly damaged. Other ships sank later, which argues that they might well have been saved if they had had on board crews capable of carrying out effective damage control. The latter appears to be the crux of the whole question of atomic warfare at sea. To what extent are the crews of warships likely to be affected by the gamma rays produced as a result of nuclear fission, what is the percentage of casualties to be expected as a result of these rays, and as a result of heat and blast, and what can be done to protect personnel against these effects ? It would seem that the possible effects upon personnel threaten to be more important than the effects on material.

Another point which must be borne in mind in a preliminary survey of the Bikini tests and their more obvious results is that the German cruiser "Prinz Eugen" was the only modern warship of any size in the target area. And in this connection it is as well to note that the "Prinz Eugen" is far from being the 10,000-ton cruiser which she was thought to be. British naval experts who examined the ship at Wilhelmshaven after the German surrender found that she had a displacement in the nature of 17,000 tons, instead of the advertised 10,000 tons, and that her structure was far stronger than that of ships of the usual cruiser design because she had been given an extra deck.

The "Prinz Eugen" suffered little damage at Bikini, and it is as well to remember in this connection that the majority of the capital ships of the Royal Navy kept in reserve at the present time are of approximately the same vintage as the "Nevada." On the other hand, the great majority of the ships so carefully laid up and kept in reserve by the United States Navy are ships of recent design and construction.

If, as seems to be indicated by the available evidence, the risk of critical damage being suffered by modern warships as a result of atomic warfare is not large, it would surely be wise to institute without delay a long-term programme of replacement for our worn out ships. Portions of the replacement programmes could surely be put in hand while consideration is still being given to the problem of the protection of personnel from the effects of atomic explosion.

In default of such a programme, one is forced to the conclusion that the year 1946 saw only the beginning of a period in which the material resources of the Royal Navy will be falling into decay. Paradoxically, the recruiting drive and the training commitments are such that it is clear that the personnel of the Royal Navy is being built up, although much of this building up is necessary in order that short service "hostilities only" personnel should be replaced by long service personnel.

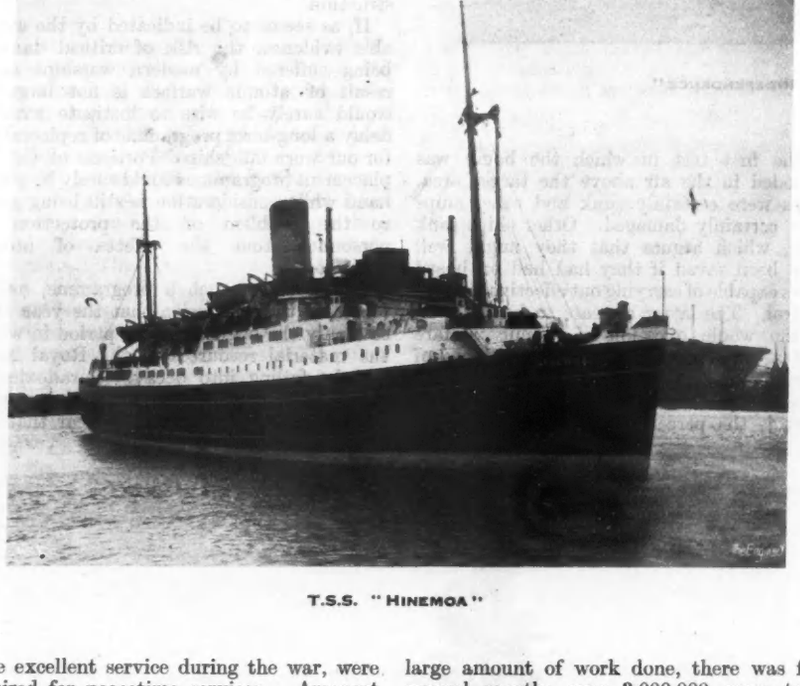


U.S.S. "NEVADA"

Shipbuilding and Marine Engineering in 1946

No. I

THE year which has just ended must be recorded as one in which a great deal of solid work was accomplished in our shipyards, ship-repairing establishments, and marine engine works. The total output returns for 1946 show that round about 1,000,000 gross tons of merchant ships were completed. Probably a further 250,000 gross tons might have been added to that million total had not there been many delays throughout the period under review. They were caused in the main by a shortage of various materials, and the very large demand for the reconditioning for service of a great number of passenger liners, cargo vessels and smaller ships, which, having done excellent service during the war, were required for peacetime services. Amongst such ships may be mentioned, the Cunard White Star liners "Queen Elizabeth" and "Queen Mary," the "Mauretania," and liners in the service of the P. & O., Royal Mail, Orient and Union Castle Companies.



T.S.S. "HINEMOA"

Some of the newer shipbuilding facilities turned over from naval shipbuilding did not come into immediate production, as they were engaged on the reconditioning of cross-Channel ships. At Queen's Island, Belfast, ships reconditioned for railway cross-Channel service during the year included the "Leinster," "Lady Connaught," "Duke of Argyll," "Royal Ulsterman," and the "Ulster Monarch." At the Walker Naval Yard of Vickers-Armstrongs, Ltd., outstanding vessels reconditioned for service included the Southern Railway steamers "Canterbury" and the "Invicta," which, during the year successively handled the "Golden Arrow" service of the Southern Railway Company between Dover and Calais. Early in December the "Canterbury," after further overhaul, began the Folkestone-Dover service to Paris and Switzerland.

Shipbuilding Capacity and Output

It can now be stated that the shipbuilding capacity of Great Britain is, at the present time, one third greater than that of 1939. That increase has been made possible by the introduction of new equipment in shipyards, often with a better layout and new cranes at the berths; the introduction of new machine tools in the plating sheds and workshops, and the extension of welding, flame-cutting, and other new processes.

Throughout the year, ship-repairing establishments were very busy, and in spite of the large amount of work done, there was for several months over 3,000,000 gross tons of shipping in United Kingdom ports and shipyards undergoing conversion or awaiting reconversion.

During 1947, it may be expected that the total number of ships completed will be still further increased, and that total again surpassed in the following year. A satisfactory feature is the fact that this year there will be a greater proportion of real high-class tonnage, specially designed and constructed for the varied uses of the shipowner, both in this country and abroad. In the second half of 1946, more particularly, there were very serious shortages of both raw materials and ship fittings, which often lengthened the time required for building and fitting out a ship or completing reconditioning work. Such shortages as lack of steel plates and angles and steel sheets for the manufacture of motors, generators and alternators, lead, for instance to long deliveries for electrical machinery. Timber, paint, sanitary ware, glass and other items were also often in short supply. Both for materials and labour, the shipbuilding industry had to compete with the housing programme and the export drive.

Shipbuilding Orders in 1946

For the last eighteen months, shipbuilding orders have been flowing in at the rate of about 1,500,000 gross tons per annum. At the end of 1946, more than 1000 ships, aggregating well over 3,000,000 gross tons, were on order or under construction. Nearly half this tonnage has not yet taken its place on shipbuilding berths. The total orders above mentioned amount in value to well over £200,000,000, which if completed on an even spreadover will probably amount to the equivalent of an annual value of output of about £66,000,000. This tonnage only takes into account the new merchant tonnage and not the naval orders or the repairing and reconversion work.

The foreign work on berths and laying down amounts to 25 to 30 per cent of the total tonnage on order, and spread over three years, which it will probably take in order to complete it, will work out at the rate of about £22,000,000 per annum. But during 1946, of course, owing to the longer times for completion caused by shortage of materials, &c., the foreign tonnage completed did not reach that figure.

An event of the year was the sending of a representative mission of shipbuilders, under the leadership of Sir Wilfred Ayre, to South America to acquaint the peoples of the South American countries with the excellent shipbuilding facilities Great Britain possesses. That mission, we are glad to state, proved successful, and it was the means of bringing towards the close of the year important orders for Argentine ships, which were placed with Vickers-Armstrongs, at Barrow-in-Furness, and with J. Samuel White and Co., Ltd., at Cowes. As the direct result of following up visits other orders from South America for less important vessels have since been received.

The principal countries from which orders were obtained for ships under construction at September, 1946, were France, Norway, the British Dominions, the Netherlands, Portugal and the Argentine.

Shipbuilding Research

Early in August, the first annual report of the Shipbuilding Research Association was issued, covering the period from April 24, 1944, to December, 1945. As recorded in last year's annual article, the formation of the Association was undertaken by the Shipbuilding Conference, with the active support of the Department of Scientific and Industrial Research, whose representative is Sir Frank E. Smith. Sir Wilfred Ayre is Chairman of the Council, Sir Maurice Denny, Chairman of the Research Board, and Dr. S. Livingston Smith the Director of Research. Most of the shipbuilding firms of this country, over seventy-six of them, have joined the Association. The Research Board has compiled a comprehensive programme which has been divided into four main groups, hydrodynamics, ship's structures, ship's performance and ship's machinery. Full use is being made of Government and University research laboratories, which include the William Froude Tank at Teddington, King's College, Newcastle-upon-Tyne, under Professor Burrill, and the tanks of member firms. Dr. G. S. Baker is helping with the hydrodynamics section. On the ship's structures side, full co-operation is being maintained with the British Welding Association, the British Iron and Steel Research Association, and the Admiralty Ship Weld-

ing Committee. Professor Sutton Pippard, of the Imperial College, London, and Mr. Muckle, at King's College, Newcastle-upon-Tyne, are assisting with structures and the use of light alloys, and arrangements with the Institute of Welding have been made to carry on the experimental work at Glengarnock, under the supervision of Mr. J. L. Adam, of the British Corporation.

On the machinery side, experimental work will proceed in the Engineering and Physics Division of the National Physical Laboratory, under Professor Lander at the Imperial College, London, and at the laboratories of the Royal Technical College, Glasgow. Dr. Dorey will supervise work undertaken with Lloyd's Register, and Professor Burstall, of Newcastle-upon-Tyne, will, it is hoped, assist in the research programme. Co-operation with the British Refractories Research Association and the British Cast Iron Research Association has been arranged. During the year there were several issues of the Association's "Journal," which is produced by the intelligence section, under Mr. E. Ower, and contains a broad and comprehensive survey of the international technical Press, in its relation to shipbuilding and marine engineering subjects.

Pametrada Research Station

On August 12, 1946, the offices of the Parsons and Marine Engineering Turbine Research and Development Association were opened at the Pametrada Research Station, Wallsend-on-Tyne. The staff has been increased, and now numbers fifty-six. Considerable progress was made in the completion of the buildings for the full-scale testing of marine machinery, consisting of the boiler house, a research building, and the turbine test house. The latter building has a bed 75ft in length, designed to withstand upward and downward reactions of 80 tons on any 2ft in the length of surface. The test house is equipped with a 75-ton overhead crane, which has been proof tested at 90 tons. The pump house, adjoining the turbine test house, was completed, and it contains propeller type pumps for the main dynamometer and auxiliary circulating water. The high-pressure Foster Wheeler boiler with a designed working pressure of 1200 lb per square inch, and an outlet steam temperature of 950 deg. Fah., was installed. It was built by Richardsons Westgarth and Co., Ltd. The 60,000 h.p. Heenan and Froude dynamometer was delivered and only awaits erection, along with other pumps and auxiliary gear.

Sanction was obtained from the Ministry of Works for extensions including a gear-testing laboratory, an electronics laboratory, a fuel and lubricating oil-testing laboratory, and a further drawing office.

During 1946 the Association produced complete detailed working drawings for turbines, condensers and gearing for the most up-to-date destroyer machinery yet produced for the British Admiralty. That work also included the solution of special problems on the tolerances of parts, the production of inspection record cards, and other matters. Basic designs produced for member firms were numerous and were 50 per cent larger than for the previous year. Over 120 preliminary designs of turbines and gearing were prepared, some of the conventional marine type, but a growing proportion, over 60 per cent, represented modern designs developed by the Association. These new designs take advantage of high-speed turbines with double reduction gearing, with a reduced number of casings, combining the advantages of less weight and cost with an improved performance.

While the Association was waiting for its buildings, several items of research works on turbine blading and diaphragms were carried out at the Heaton Works of C. A. Parsons and Co., Ltd. Reference to the Association's work on the design of gas turbines is made elsewhere in this issue.

Important Ships in 1946

Pride of place to ships in 1946 must be given to the Cunard White Star liner, "Queen Elizabeth," illustrated in to-day's Special Supplement. Her war task is well-known, and will long be remembered on both sides of the Atlantic. On Friday, December 27, 1946, she left Southampton for New York on her ninth crossing as a passenger liner. Since the "Queen Elizabeth" inaugurated her service as a passenger ship on Wednesday, October 16, 1946, she has carried more than 11,000 passengers to New York and has brought back to these shores nearly 9000, including many tourists from America.

In three articles which appeared in our issues of October 25 and November 1 and 8, 1946, we gave a full technical description of the ship and her propelling and auxiliary machinery. She is the largest liner in the world, with a length of 1031ft, a beam of 118ft, and a draught of 39ft; her measurement being 83,673 gross tons. She is designed and equipped for carrying 2288 passengers in three classes, first, cabin and tourist. Her commander is Commodore Sir James Gordon Bisset. Her chief engineer, Mr. John Swanson, C.B.E., retired towards the end of the year and was succeeded by Mr. W. Harding. Her propelling machinery comprises a quadruple screw arrangement of Parsons geared turbines, with a designed output of about 160,000 s.h.p., taking steam from twelve Yarrow side-fired boilers, with a working pressure of 425 lb per square inch and a final steam temperature of 750 deg. Fah. Four B.T.H. 2200-kW geared turbine generator sets provide the power and lighting. During the year, work was begun at Southampton on the reconditioning of the sister liner, "Queen Mary," which has been entrusted to John Brown and Co., Ltd., and John I. Thornycroft and Co., Ltd. Work was begun at dockside sheds Nos. 43 and 44 at Southampton on the building of a new maritime station for these large liners by the Southern Railway Company. Plans of that station were given in our issue of July 5, 1946.

At Birkenhead, Cammell Laird and Co., Ltd., began the reconditioning of the Cunard White Star liner "Mauretania."

Another new passenger liner of the year was the "America," the flagship of the United States Lines, which is illustrated in to-day's Supplement. She was designed and built by the Newport-News Shipbuilding and Dry Dock Company, and was converted into the S.S. "Westpoint" for American trooping services. She was reconditioned for Atlantic Service and now accommodates 1050 passengers in first, cabin and tourist classes. Her length, overall, is 723ft, with a beam 93ft 3in, and a draught loaded of 32ft 6in, the gross tonnage being 26,454. A feature of the design is the use on the first-class promenade deck of glass windows carried right down to the floor instead of terminating at handrail height. The propelling machinery comprises a twin-screw arrangement of triple expansion geared steam turbines, designed for an output of 34,000 s.h.p., at 128 r.p.m. The engine-room is between two boiler-rooms. Babcock Wilcox boilers of American design are installed. The decorations are American in character and are very pleasing. Air conditioning is applied to practically all of the 23 public rooms, and the cabin and state-room accommodation is of high standard. The "America" is commanded by Commodore Harry Manning.

The completion of the Canadian Pacific Railway Company's "Beaver" cargo ship programme was an event of 1946, and towards the end of the year we saw a technical film depicting the stages in the carrying to a successful conclusion of this important shipbuilding programme. In our issues of March 8 and 15, 1946, a full description of the "Beaverdell," shown in our Supplement, and her sister ships, the "Beaverglen," "Beaverlake" and "Beavercove," will be found. The order for these four ships was placed with the Fairfield Shipbuilding Company, Ltd., of Govan, Glasgow, and the first three were subcontracted to Lithgows, Ltd., of Port Glasgow. Fairfield's built the fourth vessel at the Govan yard. The "Beaverdell," like her sisters, has a length of 497ft 3in, with a beam of 64ft, and a depth moulded to upper deck of 42ft 8in. Her deadweight carrying capacity is 11,000 tons, and her gross tonnage 9901·7 with a service speed of 16 knots. The propelling machinery is turbo-electric and was designed by C. A. Parsons and Co., Ltd., of Heaton, and the Parsons Marine Steam Turbine Company, Ltd., in collaboration with Mr. John Johnson, the owners' consultant. The design of the main and auxiliary boilers was initiated by Mr. Johnson and was developed by Babcock and Wilcox, Ltd., and by James Howden and Co., Ltd., respectively. On trials the machinery, a full description of which will be found in our issue of March 15, 1946, developed 9000 s.h.p., on a mean draught of 16ft 8½in. The consumption was about 0·55 lb per s.h.p. for all purposes on 18,500 B.Th.U. oil fuel and that consumption rate was improved upon during the service runs of the ships.

In a valuable paper read before the North East Coast Institution of Engineers and Shipbuilders, Mr. A. W. Davis, B.Sc., of Fairfield, gave a description of the application of the reheat steam cycle, as applied in the C.P.R. "Beaver" class turbo-electric cargo liners. Thermodynamic principles were discussed, and further service results from the "Beaverglen" were quoted and analysed.

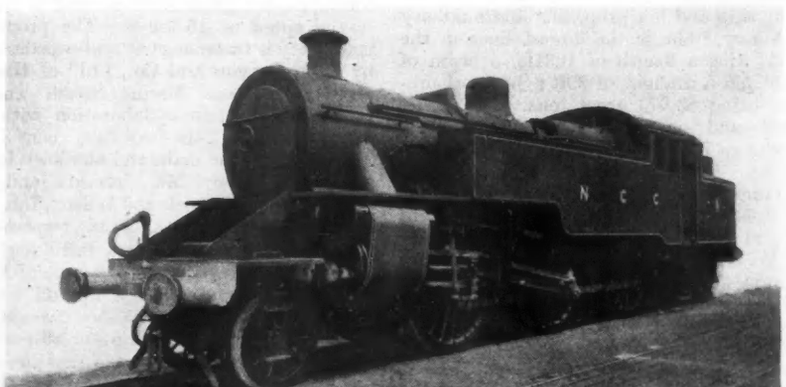
The first large passenger liner to be completed in 1946 was the "Hinemoa," herewith illustrated, which ran successful trials in the Clyde shortly before the end of the year. She was ordered by the Union Steam Ship Company, of New Zealand, Ltd., from Vickers-Armstrongs, Ltd., of Barrow-in-Furness, for the night service between Lyttelton and Wellington, New Zealand, which is now being maintained by the turbo-electric liner "Rangatira." A full description of the ship and her B.T.H. turbo-electric propelling plant will be found in our issue of June 7, 1946. We attended her trials, during which she attained a speed of 22 knots, and showed a remarkable steadiness under all powers and excellent manœuvring capacity. Designed as a night boat, she has excellent cabin accommodation. There are two public rooms, the café and the smoking room. The "Hinemoa" has a length of 400ft, a breadth of 58ft, loaded draught of 17ft, and a gross tonnage of 6900. Her turbo-electric machinery we shall deal with in our next article.

(To be continued)

Steam Locomotives in 1946

ALTHOUGH the workshops of the British main line railway companies had a particularly busy year, no new locomotives of outstanding interest were introduced into service in 1946. A fair number of new engines of known and tried types were built, but a majority of railway workshop capacity was devoted to the heavy programme of overhaul work, so much in arrears. It is natural that this overhaul work should be given precedence over new construction, in order that the high standard of efficient running, for which the railways of this country were noted prior to the war, shall be resumed as soon as possible.

The coal situation at home exerted an increasingly important influence upon locomotive running, and a large programme for the conversion of engines from coal to oil-firing was put in hand. In August the Ministry of Transport authorised the main line companies to proceed with the conversion of some 1217 heavy duty locomotives from coal to oil-firing. The number of locomotive conversions being made by each company is as follows: G.W.R., 172; L.N.E.R., 450; L.M.S., 485; and S.R., 110. As the first-named company already had 44 locomotives in course of conversion, the actual number of oil-fired engines running on its lines will eventually be 216. It is anticipated that by the new measures, some 20,000 tons of coal will be saved per week for the consumption of about 16,000 tons of oil fuel.



TANK ENGINE FOR NORTHERN IRELAND

Probably the most outstanding item of steam locomotive news during the year was that given by Mr. Bulleid, the Chief Mechanical Engineer of the Southern Railway Company, in his Presidential Address before the Institution of Mechanical Engineers. In this address brief particulars were given of the design of a new engine, of a somewhat revolutionary type it is proposed to build. All students of the locomotive are now awaiting with keen interest the outcome of the announcement, although there seems but little chance that their curiosity will be satisfied for some little time to come.

The output of private locomotive building firms steadily increased with the cessation of war commitments, although the shortage of labour and materials is still having an adverse effect on production. With the current heavy demand for locomotives of all types throughout the world, there is every indication that these firms will be working to full capacity for a long time to come. Some of the new engines built in these works during the year incorporate interesting improvements and new features of design, as will be seen from the brief particulars we are able to give later in this review.

Locomotive Work on British Main Line Railways

Great Western Railway.—During the year, the Great Western Railway Company proceeded steadily with the work of changing over locomotives from coal to oil-firing, and a number of converted engines are now giving satisfactory service. Some eighty new engines of standard types were built and no less than 2300 major overhauls and repairs were completed in the company's shops. An order was placed with British Brown Boveri, Ltd., for a 2500 h.p. gas turbine-electric locomotive, which is being designed and built in Switzerland. Preliminary information states that this locomotive will be capable of a maximum speed of 90 m.p.h., and will carry sufficient fuel for runs up to 250 miles. The continuous tractive effort at the wheel rim at a speed of 60 m.p.h. will be in the region of 13,000 lb, and at 90 m.p.h., 8800 lb.

London and North-Eastern Railway.—More than sixty new engines of standard types were put into service on the London and North-Eastern Railway, and some two thousand heavy repairs and general overhauls completed. Amongst the new locomotives were seven "A 2 Pacific's," which incorporate a number of new features. The first of these engines was "No. 500," which is illustrated in our Supplement, and was the two thousandth locomotive to be built at the company's Doncaster works. It was designed by Mr. Edward Thompson, and unlike previous three-cylinder engines built by the company has a separate set of Walschaerts valve gear for each cylinder. The inside cylinder drives on to the leading coupled axle, and the outside cylinders on to the second or intermediate axle. This design relieves some of the stress on the crank axle, and it is expected to give a longer working life than could be anticipated with the whole of the driving load concentrated on one axle.

The cylinders are 19in by 26in and have piston valves 10in diameter. These pistons have a maximum travel of 6¾in, the cut-off in full gear being 75 per cent. With a working pressure of 250 lb per square inch, the boiler has a total evaporative area of 2461·37 square feet, the superheater area being 679·67 square feet. The total adhesive weight of the engine is 147,840 lb, and at 85 per cent boiler pressure it has a tractive effort of 40,430 lb.

The crank axles and the middle large ends are balanced completely within extensions to the crank webs. Of the reciprocating weights, thirty-five per cent are balanced within the three pairs of coupled wheels.

Welded construction has been adopted for the quadrant link brackets, many of the main frame stays, and the whole of the bogie frame stays and horns.

In full working order, the locomotive, without the tender, weighs 101 tons 10 cwt, which allows for the adhesive weight of 66 tons, the maximum permitted over the L.N.E.R. for a six-coupled wheel arrangement at 6ft 6in axle spacing. The tender is of the company's standard eight-wheeled type, carrying 9 tons of fuel and 5000 gallons of water.

London, Midland and Scottish Railway.—The works of the London, Midland and Scottish Railway Company turned out some 133 new locomotives in the course of the year, in addition to completing over 4520 classified repairs. Work was started on the removal of streamlining from the original design of the streamlined "Coronation" Class 4–6–2 express passenger engines. The year's programme also included an interesting piece of conversion on two of the "Patriot" Class, three-cylinder, 5X, 4–6–0 locomotives. These engines were converted to Class 6 express passenger engines by replacing their parallel boilers with larger taper boilers of the same type as those fitted to the converted "Royal Scots."

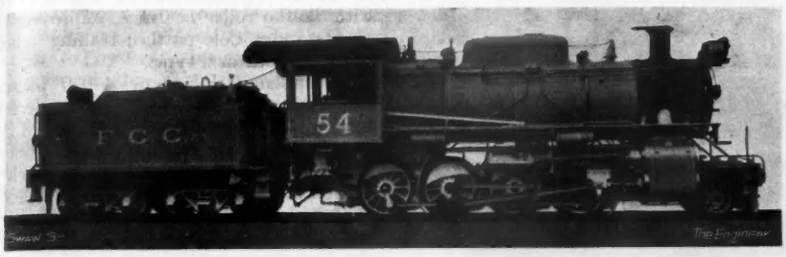
Three new Class "7 P" 4–6–2 four-cylinder passenger locomotives of generally similar design to the earlier locomotives of the non-streamlined "Coronation" Class were built for the company's express services. These engines have a boiler pressure of 250 lb per square inch, cylinders 16½in diameter by 28in stroke; and coupled wheels, 6ft 9in diameter. A double blast pipe and a correspondingly large chimney are fitted, whilst other features include a rocking grate, a hopper type ashpan and a self-cleaning smokebox.

Since grouping, the L.M.S. has built new locomotives to a strictly limited number of basic types, and from time to time modernised versions of these types, in which were incorporated the latest improvements in design, have been introduced into service. At present eleven locomotive types can cover the whole of the traffic requirements of the Company's system. Two of these types of new design were introduced late in the year and were described in some detail in our issue of December 27, 1946. They were a 2–6–0 tender and a 2–6–2 tank engine, which are being used for secondary services on cross-country and branch lines. Specially designed for this class of work, the new engines incorporate all modern developments which have proved satisfactory on the larger main line locomotives.

The two engines are practically identical in design except that one has a separate

tender and the other carries side tanks and a coal bunker on its main frames. A photograph of one of the new tender engines is reproduced in our Supplement.

The engines have two outside cylinders 16in diameter by 24in stroke, with piston valves 8in diameter, actuated by Walschaerts valve gear. With a working pressure of 200 lb per square inch, the engines have a tractive effort at 85 per cent boiler pressure of 17,400 lb. In each case the rigid wheel base is 13ft 9in, permitting the engines to take curves with a minimum radius of 4 chains. Weight distribution is such that the heaviest loaded pair of coupled wheels on the tender engine carry only a little over 13·5 tons, and on the tank engine 13·25 tons. In fully loaded running order the engine and tender weighs 84·25 tons, and the tank engine 63·25 tons.



"CONSOLIDATION" LOCOMOTIVE FOR SOUTH AMERICA—BEYER PEACOCK

Among the new engines built at the Derby works were four 2–6–4 tank engines for the Northern Counties Committee, Irish Section of the L.M.S. In most particulars and design these engines are similar to the original 2–6–4 engines of the company and they include certain modifications of the latest L.M.S. design practice. These modifications include a self-cleaning smokebox, a rocking fire-grate, a self-emptying ashpan, a side window cab, a bunker with inset coal space to allow clear vision when running in reverse, outside steam pipes to the cylinders and a redesigned smokebox saddle. To comply with N.C.C. practice, top feed apparatus is fitted on the parallel boiler; a Dreadnought type vacuum ejector is fitted and also a Detroit sight-feed cylinder lubricator. A photograph of one of the engines is reproduced in an accompanying engraving.

The leading particulars are as follows: cylinders (two), 19in by 26in; coupled wheel diameter, 6ft; total wheel base, 37ft 9in; boiler pressure 200 lb per square inch; grate area, 25 square feet; tractive effort, 22,160 lb; weight in working order, 87 tons.

Southern Railway.—In addition to its programme of overhaul and repair work, this company has been building "West Country" 4–6–2 "Pacific" locomotives, about thirty-three of which have been placed in service. The first locomotive converted to oil-burning, of the "King Arthur" Class, is at present undergoing trials.

British Built Locomotives for Abroad

South African Railways.—Among the principal engines delivered by Beyer, Peacock and Co., Ltd., during the year are the new design of Beyer-Garratt 4–8–2 + 2–8–4 locomotives for the South African Railways. One of these new engines was described in detail in our issue of March 1, 1946, and a photograph of it is reproduced in the Supplement. Twenty of the fifty engines ordered have been in service for some months and are stated to be giving good results. They are designed for general purpose work on 3ft 6in gauge, 60 lb rails, over particularly difficult terrain, having long sections of very heavy gradient with numerous sharp curves. With their tractive effort of just over 60,000 lb, the new engines are amongst the most powerful in the world working over 60 lb rails. The leading dimensions of the locomotives are given in the table below.

The boiler has a working pressure of 200 lb per square inch, and, like the firebox which has a round top, is built of carbon steel. Special quality steel has also been used in the construction of the inner firebox.

All of the 4ft diameter coupled wheels have full flanges and curves of 275ft radius, having 4½in superelevation, and gauge widening not exceeding ¾in are negotiable.

Particulars of Beyer-Garratt Locomotive

Cylinders (four), diameter by stroke	18½in by 26in
Coupled wheels, diameter	4ft
Bogie wheel, diameter	2ft 4½in
Truck wheel, diameter	2ft 10in
Wheel base, rigid	13ft 4½in
Maximum axle load	15 tons
Adhesive weight	115 tons
Total weight, in working order	184½ tons
Heating surface :—	
Tubes : 36 flue, 5½in outside diameter, 282 small, 2in outside diameter	2,328 sq ft
Firebox, including arch tubes	212 sq ft
Total evaporative	2,540 sq ft
Superheater, 1¼in diameter tubes	463 sq ft
Total	3,003 sq ft
Grate area	51·3 sq ft
Coal capacity	10 tons
Water capacity	5,650 gallons
Tractive effort :—	
At 85 per cent b.p.	63,030 lb
At 75 per cent b.p.	55,620 lb

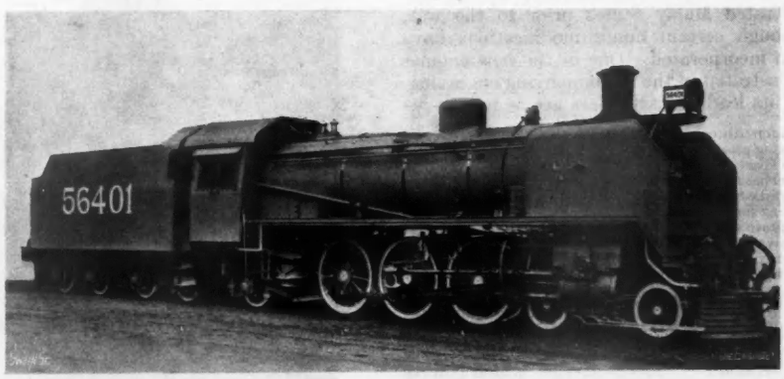
Weight distribution and balancing has received particular attention and the revolving weights are completely balanced in each wheel. A maximum loading of nearly 15 tons is reached on the driving axle and the weights decrease towards the extremities of the units.

Brazilian Railways.—A repeat order for eight double "Pacific" type Beyer-Garratt locomotives for the Leopoldina Railway in Brazil was also completed by the same company. The design of these engines followed closely that of the original locomotives built some years ago.

Peruvian Railways.—Ten "Consolidation" passenger type engines, built by Beyer, Peacock and Co., Ltd., for the Peruvian railways, are in process of shipment, six being destined for the Central of Peru Railway, and four for the Southern of Peru Railway. Twenty-two engines of this type have now been built for these railways by the company, and, although the principal dimensions are the same as those for the last order, various improvements are incorporated. The work for which the locomotives are used is particularly arduous, as both of the railways climb to great heights over severe gradient and curvature. The more spectacular line is the Central of Peru main line, which rises to 15,805ft from sea-level. There is practically 74 miles of continuous 1 in 25 gradient, the maximum being 1 in 22, taking into account the absence of compensation for curvature. The sharpest curves have a radius of 328ft. On this line there are no less than 41 bridges, 61 tunnels and 13 reversing stations.

Locomotives for Peru

	Central	Southern
Cylinders, diameter by stroke	20in by 28in	20½in by 28in
Coupled wheels, diameter	4ft 4in	4ft 8in
Boiler pressure	200 lb/sq in	200 lb/sq in
Heating Surface :—		
Firebox	137 sq ft	137 sq ft
Large tubes	416 ,,	416 ,,
Small tubes	1,139 ,,	1,139 ,,
One thermic siphon	25 ,,	25 ,,
	1,717 ,,	1,717 ,,
Superheater (inside)	341 ,,	341 ,,
Total	2,058 ,,	2,058 ,,
Grate area	28 sq ft	28 sq ft
Wheel base :—		
Engine	23ft 7in	23ft 11in
Rigid	14ft 3in	15ft 3in
Total engine and tender	49ft 2½in	49ft 2½in
Maximum axle load	16½ tons	16½ tons
Weight of engine in working order	74 tons	76 tons
Weight of tender in working order	40 tons	37½ tons
Tractive effort at 75 per cent boiler pressure	32,300 lb	31,520 lb
Factor of adhesion	4·5	4·77



LOCOMOTIVE FOR MALAYAN RAILWAYS—NORTH BRITISH

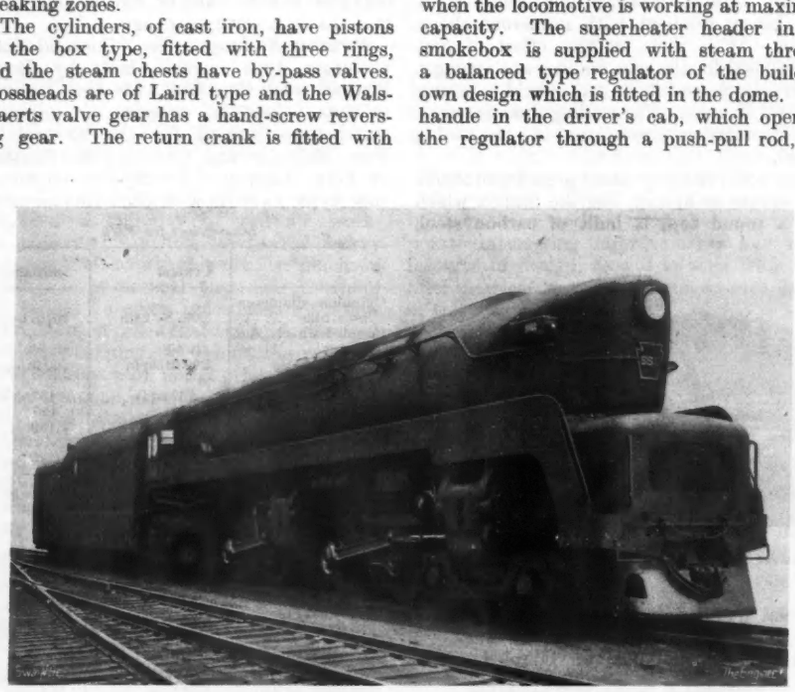
Weight distribution and balancing has received particular attention and the revolving weights are completely balanced in each wheel. A maximum loading of nearly 15 tons is reached on the driving axle and the weights decrease towards the extremities of the units.

The general dimensions of these engines, one of which can be seen in the accompanying illustration, are tabulated above.

The boiler, which has a firebox of the Belpaire type, is oil-fired and fitted with a MLS multiple valve regulator and super-

heater. The firebox has one thermic siphon and flexible stays are fitted in the breaking zones.

The cylinders, of cast iron, have pistons of the box type, fitted with three rings, and the steam chests have by-pass valves. Crossheads are of Laird type and the Walschaerts valve gear has a hand-screw reversing gear. The return crank is fitted with



CLASS "T 1" LOCOMOTIVE, PENNSYLVANIA RAILROAD

Skefko ball bearings. The front radial arm bogie has roller-bearing axle-boxes, also of Skefko manufacture, and is compensated with the leading coupled wheels, the intermediate, driving and trailing wheels forming the second group. The engine frames are of the bar type, the whole chassis being very strongly braced with steel castings to withstand the severe strains of continuous all-out working on 1 in 25 gradient.

Malayan Railways.—An order for forty 4–6–2 locomotives for the Malayan Railways was completed by the North British Locomotive Company, Ltd., and a number of "B I" Class, 4–6–0 engines are being supplied to the L.N.E.R.

The Malayan locomotives are similar to twenty-eight engines supplied to the Federated Malay States prior to the war, although certain minor modifications have been incorporated. One of the new engines is illustrated in the accompanying engraving, and its leading particulars are as follows :—

Cylinders (three)	...13in by 24in
Working pressure	...250 lb per sq in
Wheel base, rigid	...10ft
Wheel base, total	...28ft 3in
Coupled wheel diameter	...4ft 6in
Heating surface, total	...1327 sq ft
Fire-grate area	...27 sq ft
Tractive effort at 85 per cent b.p.	...23,940 lb
Weight in working order	...59 tons 10 cwt
Weight of engine and tender ...	...103 tons 16 cwt

European Railways.—In our issue of March 15, 1946, we were able to give full constructional details of the 2–8–0 "Liberation" locomotives which were built for U.N.R.R.A. by the Vulcan Foundry, Ltd., of Newton-le-Willows. Some 110 of these engines were being built during the year for distribution in Poland, Czechoslovakia and Yugoslavia, and a further ten for Luxembourg. A photograph of one of the first locomotives to be completed is reproduced in our Supplement.

The boiler, which has a working pressure of 227 lb per square inch, has 36 large and 183 small tubes, which, with the 175 square feet firebox area, give a total evaporative heating surface of 2273 square feet. A thirty-six element superheater in the large tubes has a fine-tooth sector plate to give easy and positive control.

The two 21⅝in diameter cast iron cylinders have narrow ring-pattern piston valves, 12in diameter, with cast iron heads mounted on forged steel valve spindles. A simple form of Walschaerts valve gear provides a straight line drive from the eccentric crank to the piston valve spindle and gives a valve travel of 6¾in, the maximum cut-off in full gear being 80 per cent. A one-piece motion girder in the valve gear has provision for carrying the slide bars, reversing link, reversing shaft and mechanical lubricators.

The 4ft 9½in diameter coupled wheels are of cast steel, and have balance weights cast integrally, those on the driving wheels being hollow and filled with lead. All revolving weights are balanced, as are 30 per cent of the reciprocating weights, which are evenly distributed in the leading, intermediate and trailing wheels.

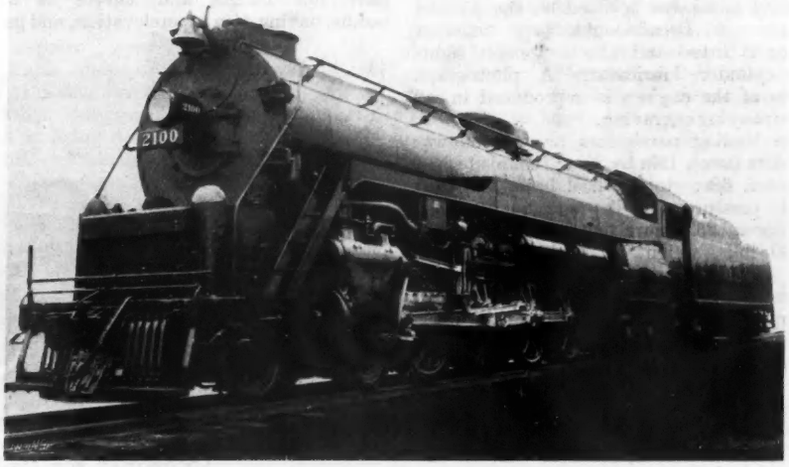
In full working order, the locomotive weighs 84·3 tons, and the tender 23·65 tons, the adhesive weight being 73·55 tons. At 85 per cent boiler pressure, the engines have a tractive effort of 43,800 lb.

Indian Railways.—Thirty-five "XE" Class 2–8–2 heavy freight locomotives built for the East Indian State Railway by the above company are of the standard Indian Government type and differ but little from their predecessors either in construction or appearance. Modifications to the new engines include big ends fitted with Skefko roller bearings, improved valve events and a Cole pattern trailing truck in place of a Cartazzi type.

Seventeen H.P.S. type 4–6–0 passenger locomotives with eight-wheeled tenders were being built by the same company for the East Indian State Railway, and four similar H.P.S. passenger engines with six-wheeled tenders for the Bengal and Assam State Railway. Although generally similar to earlier engines supplied to these railways, the new locomotives incorporate extensive modifications. In addition to a modified boiler staying arrangement, the new engines have a steel inner firebox with two thermic syphons, a dumper type ashpan and standard Indian Government boiler mountings. The frame was redesigned. The engine bogie, which is fitted with roller-bearing axle-boxes, was also re-designed. Self-trimming tenders for the engines are also fitted with roller-bearing boxes.

American Locomotives

Amongst the interesting steam locomotives under construction in the United States during the year were fifty Class "T.1" engines for the Pennsylvania Railroad. With certain modifications, the design of these engines is similar to that of the two 4–4–4–4 engines which were placed in service in 1942. As will be seen from the photograph we reproduce, a great deal of the streamline shrouding has been removed from the new engines in order to facilitate maintenance and inspection and at the same time improve ventilation. On the original engines weight equalisation was continuous from the first pair of drivers back to the rear of the engine, the leading truck serving as a front support. Now, the leading truck is equalised with the first



4-8-4 FREIGHT LOCOMOTIVE, READING RAILROAD

two pairs of drivers and the trailer truck with the last two pairs.

The locomotive has a working pressure of 300lb per square inch; the boilers have a total evaporative heating surface of 4218 square feet and there is a super-heating surface of 1680 square feet, the firegrate area being 92 square feet. The main framing comprises a single steel casting, which includes the smoke-box saddle, cylinders, complete with rear covers; poppet-valve housings and a number of brackets for various attachments.

Four 19½in by 26in cylinders are arranged in pairs, each pair driving the 80in diameter four-coupled wheels. Two steam inlet and two exhaust double-sealed valves are set at each end of each cylinder, and they are operated by oscillating cams from a cam-box between the valve housings on the cylinder. Each of the camshafts is separately operated by a connection with a gearbox containing four sets of valve gear, the primary motion for which is imparted through a connection with the crosshead through union links. Two gearboxes are fitted, one for the front and one for the rear pair of cylinders. Gear movement is controlled through an air motor in the driver's cab.

Of the total engine weight of 222 tons, over 119 tons are available for adhesion and the tractive effort at 85 per cent boiler pressure is 65,000 lb. In full working order, each engine and tender weighs over 415 tons.

Another photograph we reproduce shows one of ten 4–8–4 heavy freight locomotives, built during 1946, in the workshops of the Reading Railroad Company. These engines are similar to twenty others, the construction of which was started in 1945. Designed for use on fast freight services, they develop a tractive force of 68,000 lb, and with the booster working, 79,100 lb. In full working order, the engines each weigh just over 197 tons, and their tenders about 70 tons. Nine of the engines have roller bearings in the driving axles, and the tenth has crown-bearing journal boxes. The driving wheels are 70in diameter. The leading truck has 36in diameter wheels with roller-bearing journals, and the trailing truck 44in diameter wheels with roller bearings. A booster is set on the rear trailing truck axle.

The cylinders, pump and other brackets are cast integrally with the massive steel frame. The cylinders are fitted with cast iron bushings, and are each 27in diameter by 32in stroke. Their 13in diameter piston valves are actuated by Walschaerts valve gear.

In the firebox, which has a grate area of 94·5 square feet and a heating surface of 465 square feet, are three siphons, and an additional siphon is set in the combustion chamber. The total heating surface of 6134 square feet is made up as follows: firebox and combustion chamber, 327 square feet; arch tubes and siphons, 138 square feet; tubes and flues, 4455 square feet; superheater, 1214 square feet.

Civil Engineering in 1946

No. I

IN our corresponding civil engineering review article published last year at this time, the remark was made that 1946 could only be looked forward to with some trepidation. The dire effects of six years of war continue perforce into many years of peace, and it is now becoming increasingly evident that it is a long and uphill path which leads to the level marking the solution of the world's economic problems. Civil engineering, the art of directing the forces of Nature to the use of man, depends for its efficient prosecution on readily available materials and manpower, no less than industrial activities do. Shortages of all kinds—food, labour, materials, machinery and productive capacity—persist to a lesser or greater degree the whole world over. It is with just this background that civil engineering work has gone forward during the year on repairing the physical destruction of war.

Therefore it is perhaps not surprising that in this article we are not able to record large and spectacular feats of civil engineering as having been accomplished during the past year. The first call upon engineers in Europe and other war-torn parts of the world has been to patch and mend essential means of communication and power generation. In the face of great difficulties good progress has been made with this type of work, and some remarkable examples are briefly mentioned in this article. Secondly, even less spectacular general work of rehabilitation has gone on in many parts of the world, in repairing and converting to peaceful uses railways, roads, docks, water supply systems and other engineering works, sadly run down through overwork and through lack of maintenance, so as to fit them for the needs of the next few years. Finally, engineers, in collaboration with architects and others, have put forward comprehensive long-term plans to ensure that once the ravages of war have been overcome, their works shall proceed in an orderly manner. To several of these plans we also refer.

WILSON BRIDGE, LYONS, DESTROYED BY EXPLOSIVE CHARGES

European Reconstruction

In this first section of our review some typical examples of the efforts of civil engineers to rebuild bridges and other works in France, Belgium, Holland and Germany are described.

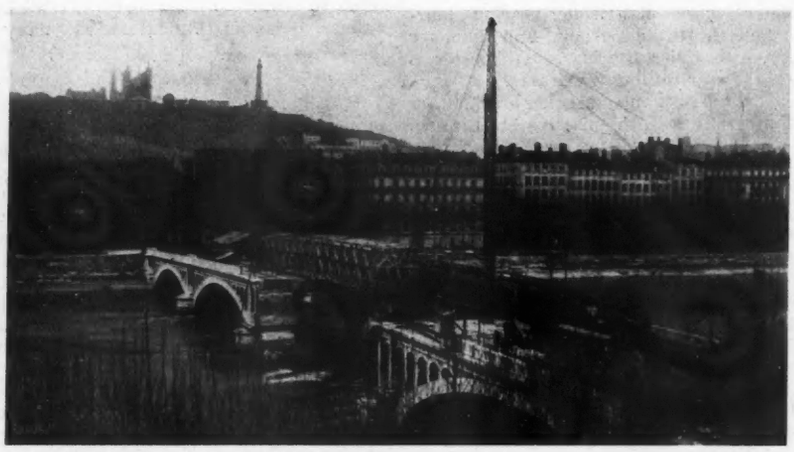
France

Possibly the greatest destruction of means of communication to occur as a result of the war was in France, which twice saw armies advancing and retreating over her soil before final victory. Her capital city was left practically unscathed, but elsewhere in many districts destruction was total. For example, the city of Lyons, intersected by two broad rivers, the Saône and the Rhône, had no fewer than twenty-four road bridges, of which twenty-two were destroyed or damaged by the retreating enemy to such an extent that they were unusable, resulting in complete paralysis of local and through traffic when liberation came. It is a tribute to French engineering genius that, short as they were of materials, some life was restored to the city within five weeks of the liberation, in September, 1944; within five months essential traffic was free to circulate; and within eighteen months, in March last year, eighteen bridges had been repaired. The total length of reconstructed spans was 1516 m out of a total of 1964 m destroyed. Monsieur André Mook-Aray, Ingénieur des Ponts et Chaussées, has published a remarkable account of this work. Space permits of the mention of one or two examples only in this article, but it is hoped that a further article will appear in THE ENGINEER dealing specifically with this work.

The Lyons bridges destroyed were of several types—steel arch, suspension and masonry and concrete. An accompanying engraving illustrates the damage done to Wilson bridge, a masonry and reinforced concrete structure spanning the River Rhône. The bridge was originally built in 1918; it has four spans of 49 m, each consisting of double masonry arches supporting a reinforced concrete decking, 20 m wide. Explosive charges placed on the roadway produced the curious result depicted. Great difficulties were met in rebuilding this structure. The damaged span effectively blocked the opening between the piers and made it impossible to erect centering to support a rebuilt arch from underneath. It was therefore decided to use suspended centering, supported by a wooden girder of 52 m length, spanning the opening. This girder, shown in course of launching in the illustration on page 28, was itself unusual, in that it was built mainly from timber planking, because of shortage of other more suitable timber sections. Work then proceeded on rebuilding the masonry arches, whilst large sections of reinforced concrete decking were prefabricated nearby on the banks of the river. The bridge was finally opened to traffic in February of last year, permanently repaired—a magnificent example of the engineer's art.

Gallièni bridge, also over the Rhône, illustrated in course of repair in one of the Supplement engravings, is of quite another type, having three steel arches spanning the river. In this case the central span, broken at the springings, fell in two hinged parts into the

river. Galliéni bridge is one of four similar bridges originally built between 1888 and 1903, each 20 m wide and with a total length of more than 200 m. All four were similarly destroyed and similar methods of repair were used in their reconstruction. As is indicated in our Supplement engraving, it was decided to raise the damaged Galliéni span, weighing some 800 tons, as a whole. Pile foundations were driven into the bed of the river, so as to divide the opening into three sections, and sets of jacks were designed to rest on these



WILSON BRIDGE, LYONS—ERECTING TIMBER GIRDER TO SUPPORT FALSEWORK

foundations. Together with other lifting tackle mounted on the piers and on the adjacent undamaged spans, this equipment permitted the raising of the damaged portions to their original place. The difficulties attendant on these manœuvres can well be imagined. At some stages there were no fewer than fifty-six men controlling simultaneously the operation of lifting jacks and winches. However, the work was brought to a successful conclusion, and similar methods were used for the repair of the other three steel arch bridges. When it is considered that this work, and at the same time difficult work on other bridges in the city, was carried out almost uninterruptedly on rivers which are notorious for the violence of their floods, under conditions of extreme shortage of labour and material, the extent of the task so quickly achieved is realised.

BELGIUM

As in France, so in Belgium many bridges and other structures, particularly on the railway network, were destroyed or damaged by bombing, sabotage or further to military operations. Taking the railway system alone, at the beginning of 1945 a total of 466 bridges were on the restoration list; of these structures, 395 were railway bridges and 71 road bridges over the railway lines. In June of last year 128 railway bridges and 13 overbridges had been permanently restored, whilst 242 bridges had been rebuilt temporarily. Thirty bridges were under reconstruction and only 44 remained to be restored. This work reflects great credit on the efforts of the engineers of the Belgian National Railways. Despite the progress made, much remains to be done. It is the opinion of the engineers that a further two years must elapse before the railways are completely rehabilitated. The main difficulties, here as elsewhere, are shortages of materials, particularly timber and steel, and shortages of manpower.

A typical rebuilt structure, the Val-Benoit bridge, across the River Meuse, carries a double-track line from Liége to Aachen and Cologne, in Germany. Work in progress on this bridge is illustrated in one of the Supplement pages. The new bridge will consist of a central riveted steel span, of the Vierendeel type, 283ft long, and two side girder spans, each about 214ft long. Before its destruction in August, 1939, the Val-Benoit bridge was a double structure, of which each half carried one railway track. In preparation for invasion Army engineers placed explosive charges, which, it appears, were inadvertently detonated by an induced electric current set up by a heavy storm. All six spans were destroyed. Examination of the broken members indicated that where the mild steel structure was broken by the direct explosive action the fractures showed no contraction in area, just as if the steel were a brittle material, but away from the neighbourhood of the explosions the steel was bent to angles of 180 deg., strained by buckling and rivet holes were elongated, as is expected with a ductile material.

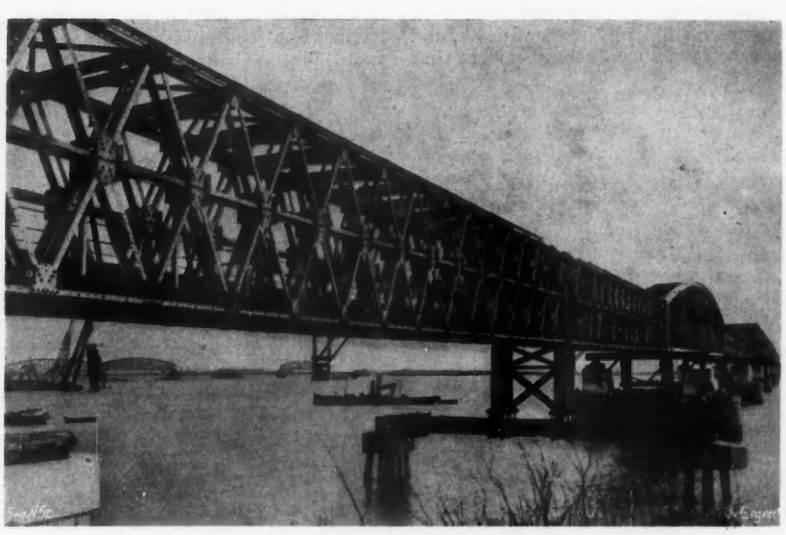
GERMANY

In Germany reconstruction has been carried out in the main by the Army engineers of the various occupying Powers. The Royal Engineers were responsible for a notable road bridge over the Rhine at Cologne, opened last June and named Patton bridge. It was the second of the semi-permanent "iceproof" bridges to be completed in the British zone of occupation, Montgomery bridge at Wesel being the other. Patton bridge, illustrated in course of erection in one of the Supplement pages, is 1480ft long, with a central 240ft navigation span and eleven approach spans, each about 120ft long. There are two carriageways, each over 10ft wide, with a cycle track in the middle. In our engraving Cologne Cathedral can be distinguished in the background on the right, and on the left can be seen the remains of the Hohenzollern bridge.

The central span of Patton bridge was erected separately in Mulheim harbour. This span was built from German SKR bridging, and it weighs 450 tons. It was built on four 1000-ton Dortmund-Ems barges, previously strengthened and joined together to form a raft, the span resting on a 50ft high Bailey bridge superstructure, which in turn rested on the raft. By thus constructing the central span separately and towing it upstream into position at least two months' time was saved. When towed into position, water was pumped into the barges and the span settled evenly on the piers prepared for it. The platform on which it had been erected was then towed out from underneath. The raft, with the span in position, weighed some 2500 tons and presented a large area to the wind; consequently the towing operation presented some anxiety, but the whole operation, which was planned in England at the Experimental Bridging Establishment at Christchurch, was, as already stated, successfully accomplished.

HOLLAND

Dislocation of transport, industry and agriculture in Holland as a result of military operations, as with most of the other occupied countries, was very severe. Bridges were wrecked, the low-lying areas were in many cases flooded, and the retreating enemy looted everything of value which was possible to carry away. But Dutch engineers, with aid from the Allies, set about repairing the damage, with great obstinacy and speed. Perhaps two of the most notable examples of Dutch reconstruction were the rebuilding of the Moerdijk bridges, across the Hollandsche Diep, south of Rotterdam, and the reclamation of the island of Walcheren, once a fertile and beautiful part of Holland,



MOERDIJK HIGHWAY BRIDGE, HOLLAND

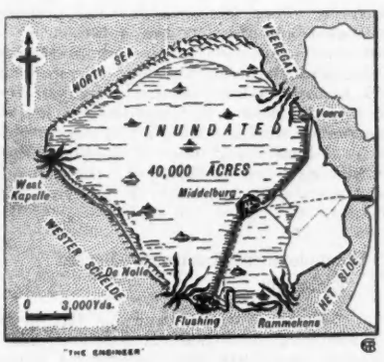
but almost entirely inundated as a result of the famous breaching of the dykes by R.A.F. bombers in October, 1944. In three of our issues last year, March 15th, 22nd and 29th, a full account of the work of closing the breaches in Walcheren dykes, contributed by P. Jansen, chief engineer for the works, was given, whilst the rebuilding of Moerdijk bridges was described in our issue of August 2, 1946.

An accompanying engraving illustrates the rebuilt Moerdijk highway bridge. The Moerdijk bridges, rail and road, are of particular importance to the Dutch, as they form the only link between western Holland and Belgium. Permanent rebuilding of these structures will take about three years, but in the meantime temporary repairs have been completed on the highway bridge and are well advanced on the railway bridge, which is claimed to be the longest railway bridge in Europe.

The highway bridge was completed in 1936 and consisted of ten lattice girder spans, each 328ft long. Four of the ten spans were destroyed, but the piers remained intact. The wrecked spans were repaired by temporarily transferring two of the intact curved top chord truss spans of the railway bridge to the highway structure. Each of the two railway spans used, weighing about 750 tons, was floated into position on caissons. The two remaining gaps in the highway bridge were filled by temporary military Callender-Hamilton trusses, each 165ft long. The width of the temporary spans allows only a single traffic lane on the repaired structure.

The railway bridge, which can be discerned in the background of the view reproduced, had a length of 4650ft. Six of the original fourteen spans were destroyed. It is proposed to shorten the railway bridge from fourteen to ten spans and to build an earth dyke, 1500ft long, in place of the missing spans. When permanently rebuilt, the piers will be widened so as to accommodate a double-line track.

Closing the breaches in Walcheren dykes presented many novel problems for the Dutch engineers. A sketch map reproduced herewith shows the island, in the Scheldt estuary, and the positions of the four



MAP OF WALCHEREN

breaches, or gaps, at Nolle, West Kapelle, Veere and Rammekens. After the bombing, Walcheren was left in a very bad position indeed, with 40,000 acres of fertile land inundated. The tidal range of about 13ft caused strong currents in the four great gaps, which together had a width of some 3000 yards. As a result a system of channels developed, which steadily eroded more and more of the precious soil, and daily made the problem of repair more difficult. A start on repairs was made without delay with hastily improvised equipment, and when the Armistice came the foundations had been laid for an organisation which might be called one of the greatest improvisations in the history of hydraulic engineering. After the Armistice activities were rapidly extended. A combination of contracting firms, the so-called M.U.Z., already well known for its work in building the great dyke across the Zuyder Zee, undertook the work. On October 15, 1945, there were 3300 persons at work with the Walcheren Dyke Repair Service, with 14 sand dredgers, 135 barges, 71 tugs, 73 landing craft, 19 big and small floating cranes, 52 draglines and bull-dozers, 29 miles of railway track and a considerable number of motor vehicles.

Space in this article does not permit a full account of the many difficulties met by the engineers, and the reader is referred to the fascinating account already mentioned above. We reproduce, however, as a typical example, a view at Nolle gap, which was the first to be tackled. In this view the gap has been narrowed considerably by pumping sand and sinking fascine mattresses between banks built of clay. Owing to the many difficulties, not the least of which was that the clay had to be transported from 60 miles away and was variable in quality, work progressed slowly and the ground gained at neap tides was partially lost at spring tides. The velocity of the current increased at spring tides to more than 10 feet per second. It was then decided to hasten progress by dumping a stone dam to a level of about 7ft below mean sea level and sinking on this foundation a series of "beetles," equipment originally forming part of the reserve for Allied invasion artificial harbours, intended for the support of floating bridges. Four of these beetles are shown in the engraving, ballasted with sand bags and placed in the gap. A sudden storm resulted in many being torn from their moorings and carried over the cill inland, undoing much of the good work. During the next neap tide the attack was renewed. With the help of good-quality clay the dyke head was pushed forward a few score of yards so that the gap measured some 66 yards across. To achieve quick results a beetle was successfully placed at right angles to the direction of the current, and encouraged by this expedient, the engineers followed it up by manœuvring a steel ship about 120ft long into the gap. It was sunk by explosive charges and then loaded with clay. One tide later one more beetle finally sealed the gap, on September 2, 1945. But soon afterwards, on September 24th, the new dyke proved to be too low to withstand stormy seas, and much of it was washed away. Further patient work succeeded in repairing the damage, and Nolle gap was once again closed.

Work on the other gaps proceeded steadily, other equipment from the "Mulberry" reserve, such as "Phœnix" caissons, being used wherever possible. The breach at Rammekens was the most troublesome of the four, and the outcome of the struggle was in doubt for a long time. However, patient and skilful endeavours resulted in finally winning back, on February 6, 1946, the last part of the island. It is recently reported that, contrary to some expectations, crops have been successfully grown on the land flooded by the sea so short a while ago.

NOLLE GAP, WALCHEREN

(To be continued)

A CHESHIRE NEW TOWN.—The Minister of Town and Country Planning has informed representatives of local authorities from the north-west of England that, as a consequence of a report received from Dr. R. C. B. Jones, a noted geologist, of Wigan, it would be ill-advised to build the proposed new town at Mobberley and Knutsford in Cheshire. Dr. Jones reported serious subsidence in the whole area. The Minister said he had been impressed by the criticisms of the original proposal to build a new town at Mobberley made at a previous meeting with the same local authorities, and he had accordingly amended his plan to include Knutsford, thus taking the new town farther from the built-up area of Manchester. The urgent Manchester housing problem and the urgent problem of dealing with the Manchester overspill made it essential that now that the Knutsford-Mobberley scheme appeared to be ruled out, no time should be lost in considering alternative sites in co-operation with the local authorities. One or more new towns would no doubt be required, as well as the expansion of existing towns. Meanwhile, borings would be carried out to ascertain the extent of the Cheshire subsidence area in co-operation with the local authorities concerned.

Industrial and Labour Notes

Sweden's Iron and Steel Industry

According to Mr. Axel Gjöres, Minister of Supply, the output of iron goods in Sweden is satisfactory, but on account of labour shortages, production is very unevenly apportioned between different kinds of goods. Whilst to talk about a depopulation of the Swedish iron industry would be an exaggeration, a very serious decrease in man power has taken place. It is estimated that approximately 2500 workers are needed to make good the man power deficit in the iron works.

It is reported, however, that the Swedish iron and steel industry is planning a considerable extension of production, which will be achieved partially by further modernisation, and also by the building of new plants. The iron works in central Sweden are said to have agreed on a five-year investment plan.

Apathy and Efficiency

Addressing the annual general meeting of Hale and Hale, Ltd., held recently at Dudley, the chairman, Mr. W. Edgar Hale, referred to the extraordinary state of apathy which, he said, had developed among quite a considerable section of the population. He urged that it must not be allowed to go on if we were ever likely to achieve and maintain that improved standard of living which every right-thinking person so strongly desired.

Mr. Hale suggested that a changed and broadened outlook was urgently and vitally necessary, or a national disaster would be inevitable in a few years, when not only our newer social developments would be in jeopardy but also the older ones. At the moment, mild inflation and other similar agents were to some extent filling the gap, but they could not continue indefinitely. As the United Kingdom was the most heavily involved nation in international trade, it had one day to face, whether it liked it or not, keen international competition in its export markets.

Apathy and efficiency, Mr. Hale added, never were successful bed-fellows. At present, on the Continent, the highest efficiency was evident, absorbed in obliterating the scars of war, but that efficiency would shortly find itself engaged in supplying the general needs of the world, and it was then that our troubles would really begin, unless we took time by the forelock and used our national genius to the best advantage.

Census of Production Plans

In the Statistics of Trade Bill recently introduced into the House of Commons, the Government is implementing the recommendations of the Nelson Committee regarding an annual census of production. In announcing the Government's acceptance of these recommendations, the President of the Board of Trade stated that the first full census would be taken for the year 1947, and that a partial census involving a limited number of industries would be taken in respect of 1946.

According to the *Board of Trade Journal*, the industries in question are : mechanical engineering, electrical engineering, hardware and sheet metal, tool and implement, chemicals, clothing, printing and bookbinding, and building and contracting. The statutory schedules, on which firms engaged in these industries are asked to make their returns for 1946, will shortly be issued by the Census of Production Office. They have been formulated after consultation with each of the trades concerned. One of the purposes of this partial census is to obtain information as to the progress of the industries to be covered, and, as will be seen from the foregoing list, certain of the important "capital goods" industries of the country are included.

It is recognised that 1946 has been a year of transition, and that the period of reconversion from war to peace conditions is still incomplete. Accordingly, comparisons of output in 1946 with outputs in other years will not give a completely satisfactory picture of the changes which have occurred in industrial production. The question of the productivity of industry has, however, become extremely important in view of the restricted labour force, and experience in studying the problems involved is necessary before it can be ascertained what are the essential figures to be collected in future.

An International Management Congress

Plans are now being completed for an International Management Congress to be held in Stockholm during the coming summer. It is stated that several countries have already notified their intention to send delegates, among them being the United Kingdom, Canada, Australia, the U.S.A., France, Brazil, Czechoslovakia, Holland and Greece.

The Congress is being organised by the Swedish National Committee on Scientific Management, the chairman of which is Mr. K. F. Göransson. It is understood that the discussions will cover many problems having an important bearing on all aspects of modern industrial and economic life throughout the world.

The T.U.C. and the New Year

Mr. Vincent Tewson, the general secretary of the T.U.C., has issued a New Year message to trade unionists in which he says that the demanding and securing of rights brings in its train the acceptance of responsibilities. During the long years of war, the message continues, the trade union movement gave ample demonstration of its acceptance of responsibility, and in the coming year that attitude must be maintained. Trade unionists, Mr. Tewson urges, must work for peace with the same determination as they worked for victory, and with even greater understanding directing their efforts.

Nickel in 1946

In a letter which he has addressed to shareholders, Mr. R. C. Stanley, president of the International Nickel Company of Canada, Ltd., has surveyed the progress of the nickel industry during the past year. Operations in Canada, Mr. Stanley states, are now running at 75 per cent of the enlarged productive capacity, closely approximating the rate prevailing in 1937, when a record tonnage of nickel was sold. Although mining, smelting and refining costs have increased substantially, apart from bringing United States nickel prices into line with prices in the world market, no price increase has been made or is contemplated.

Mr. Stanley's letter goes on to say that trends of consumption during the year show that over 35 per cent of the nickel used in the world is absorbed in stainless steels, which, he thinks, will find increasing markets, particularly for industrial equipment. Plating has accounted for more nickel in 1946 than in any year previously, showing an increase of over 50 per cent on pre-war consumption. In the U.S.A. there was a similar spectacular increase in the production of nickel silver.

Trade Delegation from Italy

An Italian trade delegation, led by Dr. Luciano Mascia, has recently visited this country for discussions with the Board of Trade and other Government departments about a wide range of questions affecting the resumption and development of trading relations.

The Italian delegation pointed out the necessity for Italy to devote her sterling resources mainly to those raw materials and semi-manufactured goods essential to her industrial recovery, and the United Kingdom delegation was able to indicate a number of such materials which should be available to Italy for payment in sterling. The discussions also covered questions relating to the import into Italy of other goods from the United Kingdom; goods required by the United Kingdom from Italy; the extension to Italy of the "token import" and "war shattered" import schemes; the administrative arrangements in both countries affecting foreign trade; and the possibilities of industrial co-operation between the two countries.

The Board of Trade states that no formal trade agreement is being signed as a result of the talks which were essentially exploratory. It was agreed that a committee of officials of the two Governments should meet when necessary to review the progress of trade between the United Kingdom and Italy. As well as examining any difficulties which may arise, this committee will consider any further measures desirable for the development of commercial and industrial relations between the two countries.

Post Office Workers

The Postmaster-General, Lord Listowel, has decided that he cannot agree to a claim put forward by the Union of Post Office Workers that it should be regarded as the only staff association entitled to negotiate on behalf of the rank-and-file manipulative grades employed in the G.P.O. The union is the largest staff organisation in the Post Office, and, in the main, represents postmen, telegraph and telephone operating staff, and staff employed at counters and in sorting offices. It is stated that the union did not claim that there should be a "closed shop" in the G.P.O., but its claim, nevertheless, involved the exclusion as negotiating bodies of a number of smaller staff organisations.

Lord Listowel met representatives of the Union of Post Office Workers, and, subsequently, representatives of the other organisations. After considering all the views put forward, he has decided that the Union's claim must be rejected, as it would not be just to ignore the views of responsible and properly constituted minority bodies representing a substantial proportion of the organised staff in the grades which they seek to represent. Lord Listowel admitted that administrative difficulty did arise when negotiations had to be carried on with several different associations, but he did not think that it would be right to withdraw recognition of the smaller bodies merely for the sake of removing that difficulty.

Unemployment Insurance Benefit Extension

By the National Insurance (Extension of Unemployment Benefit) Regulations, dated December 21st, 1946, the Government authorises the extension of the statutory period during which an insured person may receive unemployment benefit, Insurance benefits are not normally payable for more than about seven months, but it is estimated that there are about 60,000 people who will be eligible for the extended period of benefit.

The National Insurance Act makes provision for the extension of benefit rights, in appropriate cases, on the advice of a local tribunal. The Act does not become fully operative until next year, and as circumstances for which this special provision was made have already arisen—mainly in the development areas—the regulations have been framed to deal with them during the interim period.

French Engineering News

(From our French Correspondent)

PARIS, December 27th.

Latest information published on the present equipment of the steel industry shows that there are 108 blast-furnaces, mainly producing Thomas iron. The average capacity of each blast-furnace is 300 tons a day, or 100,000 tons a year. Total capacity is 8,500,000 tons a year. Fifty-one blast-furnaces are distributed among other plants, producing other types of iron. Here, average capacity of each is 150 tons a day or 50,000 tons a year. Total capacity is 1,800,000 tons a year. The steel plants include: 18 Thomas steel plants, altogether producing 9 to 10 million tons a year; 49 Martin plants, comprising 142 ovens of 10 to 120 tons capacity, producing between 3 and 3½ million tons a year; 35 electro-steel works, producing about 1 million tons a year; 5 plants, comprising 12 crucible ovens, producing 10,000 tons a year. Rolling mills are largely the same as pre-war, and production capacity is far greater than the steel production can satisfy. It is, however, possible that a certain number will be modernised to increase efficiency.

* * *

The electricity crisis is being considerably aggravated by the coal shortage, and there are demands that the present electricity cuts should give way to a comprehensive "distress" plan. It is pointed out that the consumption of coal by electricity plants must be reduced, particularly as hydraulic production, which is not sufficient to cover demands, may be reduced drastically by a period of dry cold weather, which would reduce the level of reservoirs rapidly. The present system, it is urged, should give way to drastic cuts, even on certain public services, such as the underground and passenger trains, as well as in extensive illuminations, and in the meantime a comprehensive plan should be studied to come into effect as soon as possible.

* * *

Among the projects being studied by railway technicians is one for the electrification of the circle south of Paris. This important artery forms the link between the West, South West and East of the S.N.C.F, and electrification would include a part of the Versailles-Sucy line, as well as the Massy-Orly line, which is a direct link between Versailles and Valenton.

The section between Juvisy-Valenton is already finished and the first trains will run between Massy-Versailles in January. A great goods service is destined to speed up present time tables, which will be facilitated by goods stations linked with the Paris region.

Goods trains will carry loads of 800 tons or 1200 tons on certain sections, and their speed will reach 50 kilometres an hour. Passenger trains will also be improved, comprising one train an hour between 4 a.m. and 10 p.m., and two during peak hours. These will consist of engine and trailer carrying 300.

The future development of the Orly aerodrome is likely to be considerably facilitated by this service, which will later be extended to provide a common Metro-S.N.C.F. programme.

* * *

French coal deficits are likely to be 1,600,000 tons for the last quarter of this year. October imports which should have been 930,000 tons, were only 720,000 tons, while only 800,000 tons out of 1,300,000 tons were received in November. Deficit for December is so far 850,000 tons. The Government is asking the United States if the 200,000 tons which should be delivered in January could be expedited. A number of mines which had been unworked for some years were once more brought into use during the war, and are now producing scarcely enough to warrant exploitation. Lignite seams, for example, are being worked in increasingly bad conditions, which renders them less economical, and it is obvious that the 1941–43 output cannot be repeated. In the Aude, the Agel mines are experimenting with agglomeration to produce a better type of fuel. In the upper Pyrénées, extraction and treatment of lignite is proceeding.

Notes and Memoranda

Rail and Road

TWO RAILWAY ACCIDENTS.—On Friday, December 27th, three passengers were injured when the locomotive and all twelve coaches of the 2.20 p.m. train from Bournemouth to London, on the Southern Railway, jumped the rails south of Byfleet, Surrey. The train had just passed Woking, when it left the rails and, travelling along the permanent way, the engine coming to rest on the ramp of Byfleet station platform. Both up lines were blocked for some time and the down line on the embankment was closed because of the danger of the derailed locomotive toppling over. A bus service between Woking and Weybridge was established until the lines were cleared. The passengers travelling in two trains from Leeds and from Hull were shaken, and twenty-four were slightly injured, when a collision took place on Monday, December 30th, at Doncaster Station, on the L.N.E.R. line. The train from Leeds to King's Cross was about to stop when it came into collision with the rear of a train from Hull to King's Cross, which was standing in Doncaster Station. Two coaches of the standing train were splintered; several coaches of both trains were damaged and some were derailed. The up line from London through Doncaster was blocked for over three hours after the collision had taken place, and trains were diverted to other lines.

BUENOS AYRES LOCOMOTIVE FUEL.—Speaking at the recent annual meeting of the Buenos Ayres Great Southern Railway Company, Viscount Davidson, the deputy chairman, said that in the early months of 1946 the fuel position was more acute than at any time during the war. Supplies of local fuel oil were becoming scarcer and only very occasional cargoes of coal from South Africa and the United States were being received, while none had been available from the United Kingdom. Consequently enormous quantities of inferior wood fuel had to be burnt. This meant the withdrawal from normal commercial service of a very large number of wagons—nearly 3000 on the Southern and Western together—for the carriage of the companies' wood fuel. The resulting shortage of wagons and the unsatisfactory qualities of wood as a fuel called for the most strenuous efforts in order to avoid a complete breakdown in transport. Fortunately, circumstances had altered for the better since the beginning of 1946, when adequate supplies of imported oil fuel became available and once a sufficient number of locomotives had been converted back from wood to oil-burning. The prospects of obtaining suitable coal in satisfactory quantities were so poor, Lord Davidson added, that the company had decided on a further extensive programme of conversion of locomotives from coal to oil and eventually about 75 per cent of its locomotives would be oil-burning.

Air and Water

SWEDEN'S SHIPPING LOSSES.—Statistics compiled by the Swedish Board of Trade show that the losses of Sweden's merchant navy during the war period were 235 ships, aggregating 546,209 tons. In addition, twenty-five vessels, aggregating 45,681 tons, were seized and confiscated by the Germans.

SWEDISH PASSENGER AIRCRAFT.—The "Saab-Scandia," claimed to be the largest passenger aircraft designed and built in Sweden, has recently completed a test flight. It has been constructed by the Saab Aircraft Company, is equipped with two Pratt and Whitney engines of 1450 h.p. each, and accommodates thirty-two passengers. Its maximum speed is said to be 251 m.p.h., with a cruising speed of 222 m.p.h. Aircraft of this type, intended for long-distance traffic, will be arranged to accommodate twenty-four passengers in order to ensure increased space and comfort.

Miscellanea

TELEVISION PRACTICE.—A course of twelve lectures on "Television Practice" is to be given at the Northampton Polytechnic, St. John Street, London, E.C.1, on Friday evenings, at 7 p.m, beginning on January 17th. The fee for the course is 15s.

THE MINISTRY OF DEFENCE.—The Ministry of Defence was formally constituted on Wednesday last, January 1st, under Mr. A. V. Alexander. Sir Henry Wilson Smith is Permanent Secretary to the new Ministry, and Lieut.-General Sir Leslie Hollis is Chief Staff Officer. As already announced, Sir Henry Tizard will serve as Chairman of the Defence Research Policy Committee.

NON-FERROUS SCRAP.—The Ministry of Supply states that Government stocks of non-ferrous scrap metals on charge on November 30th totalled 153,334 tons. Sales for the two-month period of October and November amounted to 22,487 tons, valued at approximately £1,200,000. Material put out to tender during this period totalled 12,570 tons, of which 6925 tons were lead.

NEW IRON AND STEEL ORDER.—The Minister of Supply has made the Control of Iron and Steel (No. 55) Order, which came into force on January 1st. The Order amends the maximum prices of certain steel products, the principal alterations being increases in the price of wire ropes, brake cable, tinned steel wire and high-carbon cold-rolled strip. The order also provides for a reduction in the quantity of conduit tubes that may be acquired without licence, and releases shell steel discards from price control.

CABLE AND WIRELESS, LTD.—Before Parliament adjourned for Christmas, the Chancellor of the Exchequer announced that January 1st was the appointed day under the Cable and Wireless Act, 1946. On that day, the balance of the shares of Cable and Wireless, Ltd., passed into Government hands. The board of directors appointed to operate from the same date is as follows:—Sir Stanley Angwin, chairman; Mr. John Innes, managing director; Major-General L. B. Nicholls, Mr. A. Black and Mr. C. N. Gallie. The Chancellor indicated that the two last-named would serve part time, and that one further part-time member might be appointed to the board.

SPIRALLY GUIDED GASHOLDERS.—At the recent autumn research meeting of the Institution of Gas Engineers a paper on "Roller Carriages for Spirally Guided Gasholders" was presented by Mr. F. M. Birks, managing director of the Gas Light and Coke Company. The paper, which has now been published by the Institution, says that observation of the behaviour of spirally guided gasholders, spread over a number of years, tends to show that they suffer from considerable wear of the roller axles and bearings, particularly those gasholders which rise and fall at high speeds. Investigation into the cause of this wear shows that owing to maladjustment in the initial setting of the carriages, the theoretical distribution of the loads imposed on the rollers seldom or never occurs in practice.

RADIO HOUSE, COPENHAGEN.—A brochure, published by Standard Telephones and Cables, Ltd., Connaught House, Aldwych, W.C.2, contains some interesting illustrations of the broadcasting equipment recently installed in Radio House, Copenhagen. Radio House contains nineteen studios, ranging from the smallest, fitted with one microphone and interval chimes, to the largest, which is equipped for six microphones and has seating accommodation for an audience of 1200. There are also two "echo" rooms for the production of artificial reverberation effects. Conditioned air helps to stabilise studio acoustics, while in certain studios acoustics can be controlled by adjusting special louvres which cover sound-absorbing materials on the walls. There are three main control rooms, each with its loudspeaker, studio indicator panel and main control desk (an illustration of which is contained in the brochure). Further photographs show the arrangement of amplifier equipment and of the automatic selection equipment which is used to connect studio outputs to the control desk input channels.

CONFERENCE ON PULVERISED FUEL.—A conference on pulverised fuel is being organised under the direction of the Institute of Fuel and will be held in Harrogate on June 3rd, 4th, 5th and 6th. Over fifty papers are to be contributed from the electricity supply industry, water-tube boilermakers, the Fuel Research Station, the British Coal Utilisation Research Association, the National Coal Board, the British Refractories Research Association and from other branches of British industry concerned with the manufacture and use of pulverised fuel-fired plant. Contributions are also expected from South Africa, Australia, the U.S.A., France, Holland and Germany. For the conference week an attractive programme of social events is also being arranged. Membership of the conference will not be confined to members of the Institute, but will be open to anyone interested in pulverised fuel. The full programme is not yet complete, but the Pulverised Fuel Conference Committee has opened a list of persons interested (apart from members of the Institute) to whom full particulars will be sent as soon as they are available. Requests for names to be added to this list should be sent to the Pulverised Fuel Conference Committee, Institute of Fuel, 18, Devonshire Street, London, W.1.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of British Chemical Manufacturers

Tuesday, Jan. 28th.—MANCHESTER BRANCH: Reynolds Hall, College of Technology, Manchester. "Fuel Efficiency in the Chemical Industry," A. C. Dunningham. 3 p.m.

Association of Supervising Electrical Engineers

Tuesday, Jan. 21st.—Lighting Service Bureau, 2, Savoy Hill, W.C.2. "Delicolor Equipment," E. E. Faraday. 6.15 p.m.

Bradford Engineering Society

Monday, Jan. 6th.—Technical College, Bradford. "Fuel Economy in Facts and Figures," W. Goldstern. 7.15 p.m.

Monday, Jan. 20th.—Technical College, Bradford. "Valve Design," E. A. B. Greaves. 7.15 p.m.

British Interplanetary Society

Saturday, Jan. 4th.—St. Martin's Technical School, Charing Cross Road, W.C.2. "The Energy and Stability of Atomic Nuclei," L. R. Shepherd. 6 p.m.

Derby Society of Engineers

Monday, Jan. 13th.—School of Arts, Green Lane, Derby. "Industrial Electronics," P. Bowles. 7 p.m.

Diesel Engine Users Association

Thursday, Jan. 16th.—Caxton Hall, Westminster, S.W.1. "Recent Developments in Heavy Oil Engine Lubrication," R. A. Collacott. 2.30 p.m.

Illuminating Engineering Society

To-day, Jan. 3rd.—BIRMINGHAM CENTRE: Imperial Hotel, Temple Street, Birmingham. "Industrial Decoration," J. H. Nelson. 6 p.m.

Institute of Economic Engineering

Tuesday, Jan. 7th.—MIDLAND REGION: James Watt Memorial Institute, Great Charles Street, Birmingham. "Electro-Plating Shop Costing," A. W. Wallbank. 6.30 p.m.

Institute of Marine Engineers

Tuesday, Jan. 14th.—85, The Minories, E.C.3. "The Phosphate Treatment of Wearing Parts of Machinery," R. E. Shaw. 5.30 p.m.—BELFAST JUNIOR SECTION: College of Technology, Belfast. "The Launching of Ships," Denis Rebbeck. 7.30 p.m.

Institute of Physics

Friday, Jan. 17th.—INDUSTRIAL RADIOLOGY GROUP: Electric Lamp Manufacturers' Association, 2, Savoy Hill, W.C.2. "Sonic Methods in Non-Destructive Testing," R. Meakin. 6.30 p.m.

Institute of Welding

Saturday, Jan. 18th.—W. SCOTLAND BRANCH: North British Station Hotel, George Square, Glasgow. Annual luncheon. 1 p.m.

Institution of Automobile Engineers

Tuesday, Jan. 7th.—Inst. of Mechanical Engineers, Storey's Gate, S.W.1. "Some Problems of Cylinder Bore Wear," W. A. Robotham. 6 p.m.

Institution of British Agricultural Engineers

Tuesday, Jan. 14th.—Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "The Mechanical Requirements of the Small Grower and Horticulturist," A. P. Bevan. 2 p.m.

Institution of Chemical Engineers

Tuesday, Jan. 7th.—Geological Society, Burlington House, Piccadilly, W.1. "Chemical Engineering Aspects of the Fischer-Tropsch Process," C. C. Hall and A. H. Taylor. 5.30 p.m.

Institution of Civil Engineers

To-day, Jan. 3rd.—Great George Street, S.W.1. "How a Railway is Built: Track, Stations, Tunnels and Bridges," L. G. B. Rock. 3 p.m.

Monday, Jan. 6th.—Great George Street, S.W.1. "How Trains are Run: Signals, Train Controls and Timetables," O. S. Nock. 3 p.m.

Thursday, Jan. 9th.—BIRMINGHAM ASSOCIATION: James Watt Memorial Institute, Great Charles Street, Birmingham. Chairman's Address, H. J. B. Manzoni.

Friday, Jan. 31st.—YORKSHIRE ASSOCIATION: Great Northern Station Hotel, Leeds. Twenty-sixth annual dinner. 7 p.m.

Institution of Electrical Engineers

Monday, Jan. 6th.—S. MIDLAND CENTRE: James Watt Institute, Great Charles Street, Birmingham. "Development and Design of Colonial Telecommunications Systems and Plant" and "General Planning and Organisation of Colonial Telecommunications Systems," C. Lawton and V. H. Winson. 6 p.m. (Joint meeting.)

Tuesday, Jan. 7th.—N.-WESTERN CENTRE: Engineers' Club, Albert Square, Manchester. "The Influence of Resistance Switching on the Design of High-Voltage Oil Circuit Breakers," H. E. Cox and T. W. Wilcox. 6 p.m.

Monday, Jan. 13th.—N. EASTERN CENTRE: Neville Hall, Westgate Road, Newcastle-on-Tyne. "The Influence of Resistance Switching on the Design of High-Voltage Oil Circuit Breakers," H. E. Cox and T. W. Wilcox. 6.15 p.m.

Tuesday, Jan. 14th.—SCOTTISH CENTRE: Royal Technical College, George Street, Glasgow. "Fundamental Legislation for Electricity Supply to Consumers," W. Fennell. 6.15 p.m.—N. MIDLAND CENTRE: Corporation Electricity Department, Whitehall Road, Leeds. "Silicon Carbide Non-ohmic Resistors," F. Ashworth, W. Needham and R. W. Sillars. 6 p.m.

Saturday, Jan. 18th.—N. MIDLAND STUDENTS: Corporation Electricity Department, Whitehall Road, Leeds. Chairman's Address, A. G. Connell. 2.30 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, Jan. 7th.—39, Elmbank Crescent, Glasgow. "Recent Developments in Coal-Mining Practice," R. A. Moore.

Tuesday, Jan. 21st.—39, Elmbank Crescent, Glasgow. "Longitudinal Bending Moments in Ships," J. M. Murray.

Institution of Factory Managers

Saturday, Jan. 25th.—Waldorf Hotel, Aldwych, W.C.2. Annual general meeting. 2.30 p.m.

Institution of Heating and Ventilating Engineers

Wednesday, Jan. 8th.—Inst. of Mechanical Engineers, Storey's Gate, S.W.1. "District Heating," D. V. H. Smith. 6 p.m.

Monday, Jan. 13th.—MANCHESTER BRANCH: Milton Hall, Deansgate, Manchester. "Unit Heaters," H. Y. Turnbull and H. Hoyle. 7 p.m.

Institution of Locomotive Engineers

Wednesday, Jan. 15th.—Inst. of Mechanical Engineers, Storey's Gate, S.W.1. "Organisation and Carrying out of Examinations and Repairs of Locomotives at Running Sheds, in Relationship to Locomotive Performance and Availability," Lieut.-Col. Harold Rudgard. 5.30 p.m.

Institution of Mechanical Engineers

To-day, Jan. 3rd.—Storey's Gate, St. James's Park, S.W.1. "The Development of Aircraft Hydraulic Machinery," H. G. Conway, S. M. Parker and D. A. L. Robson. 5.30 p.m.

Monday, Jan. 6th.—N. EASTERN BRANCH: Mining Institute, Neville Hall, Newcastle-on-Tyne. "The Development of an Axial Flow Gas Turbine for Jet Propulsion," D. M. Smith: "Practical Aspects of Cascade Wind Tunnel Research," K. Watson Todd. 6 p.m.

Friday, Jan. 10th.—Storey's Gate, St. James's Park, S.W.1. "The Development of an Axial-Flow Gas Turbine for Jet Propulsion," D. M. Smith: "Practical Aspects of Cascade Wind Tunnel Research," K. W. Todd. 5.30 p.m.

Institution of Post Office Electrical Engineers

Monday, Jan. 6th.—Inst. of Electrical Engineers, Savoy Place, W.C.2. "The Provision of Line Communications for the Fighting Services," H. R. Harbottle. 5 p.m.

Institution of Production Engineers

Monday, Jan. 6th.—YORKSHIRE SECTION: Hotel Metropole, Leeds. "Training Within Industry," Peter Smith. 7 p.m.

Wednesday, Jan. 8th.—LUTON SECTION: Central Library, Luton. "Manufacture and Application of Sintered Carbides," H. Eckersley. 7 p.m.—NOTTINGHAM SECTION: Victoria Station Hotel, Nottingham. "Apprenticeship Training," B. P. Cooper. 7 p.m.

Friday, Jan. 10th.—N.-EASTERN GRADUATES: Neville Hall Mining Institution, Newcastle-on-Tyne. "Elementary Principles of Cutting Tool Design," T. Burton. 6.30 p.m.

Tuesday, Jan. 14th.—BIRMINGHAM GRADUATES: James Watt Memorial Institute, Great Charles Street, Birmingham. "The Manufacture of Optical Glass," R. E. Bastick. 7.15 p.m.

Wednesday, Jan. 15th.—BIRMINGHAM SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham. "Management in Action," W. C. Puckey. 7 p.m.

Thursday, Jan. 16th.—LEICESTER SECTION: College of Technology, Leicester. "Line Production of Footwear," E. Eatough. 7 p.m.—GLASGOW SECTION: Inst. of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow. "Measurement of Surface Finish," C. Timms. 7.30 p.m.

Friday, Jan. 17th.—WESTERN SECTION: Grand Hotel, Broad Street, Bristol. "Crushing Wheels for Form Grinding," G. H. Ashbridge. 6.45 p.m.

Institution of Structural Engineers

Thursday, Jan. 9th.—11, Upper Belgrave Street, S.W.1. "Extensibility and Modulus of Rupture of Concrete," R. H. Evans. 6 p.m.

Thursday, Jan. 23rd.—11, Upper Belgrave Street, S.W.1. "The Stress Grading of Timber and its Influence on Structural Design," E. H. Nevard. 6 p.m.

London Association of Engineers

Saturday, Jan. 4th.—Charing Cross Hotel, W.C.2. Two films. "Magic Wand of Industry" and "The Prevention and Control of Distortion." 6.30 p.m.

Manchester Association of Engineers

Friday, Jan. 24th.—Engineers' Club, Albert Square, Manchester. "The Work of the National Physical Laboratory," Sir Charles Darwin. 6.45 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Friday, Jan. 17th.—Mining Institute, Newcastle-on-Tyne. "Application of Modern Management Methods to the Shipbuilding Industry," F. A. J. Hodges. 6 p.m.

Royal Aeronautical Society

Thursday, Jan. 16th.—Inst. of Civil Engineers, Great George Street, S.W.1. Film, "In Occupied Japan." 6.30 p.m.

Thursday, Jan. 30th.—Inst. of Civil Engineers, Great George Street, S.W.1. "Wartime Developments in Air Transport," Sir Ralph Cochrane. 6 p.m.

Royal Society of Arts

Wednesday, Jan. 22nd.—John Adam Street, Adelphi, W.C.2. "Gas Turbines," Sir Claude Gibb. 5 p.m.

Rugby Engineering Society

Wednesday, Jan. 15th.—Corporation Electricity Department, Rugby. "An Outline of the Relaxation Method, with Illustrations from Recent Developments," D. N. de G. Allen. 7.30 p.m.

Sheffield Society of Engineers and Metallurgists

Monday, Jan. 20th.—Royal Victoria Station Hotel, Sheffield. "Recent Developments in the Aluminium Industry," C. J. Smithells. 6.15 p.m.

Society of Instrument Technology

Friday, Jan. 10th.—SCOTTISH SECTION: Royal Technical College, Glasgow. "Humidity," A. Lees. 7 p.m.—MIDLAND SECTION: Chamber of Commerce Building, New Street, Birmingham. "Electronic Instruments," D. Edmundson. 7 p.m.

Stephenson Locomotive Society

Saturday, Jan. 4th.—EDINBURGH BRANCH: L.N.E.R. Offices, Calton Hill, Edinburgh. "Great North of Scotland Railway," W. D. M. Stephen. 3 p.m.

Wednesday, Jan. 8th.—32, Russell Road, Kensington, W.14. "Railway Preferences and Prejudices," Norman Harvey. 7.30 p.m.

Saturday, Jan. 11th.—LEEDS BRANCH: Y.M.C.A., Albion Place, Leeds. "Some Railway Journeys," A. E. Robinson. 2.30 p.m.

Women's Engineering Society

Thursday, Jan. 9th.—MANCHESTER BRANCH: Engineers Club, Albert Square, Manchester. "Heating and Ventilation," Miss F. B. Fairbrother. 6.30 p.m.

Personal and Business

MR. A. WILLIAMS, M.I.A.E., has been appointed general manager of Trojan, Ltd.

DR. R. J. SARJANT has been appointed to the Chair of Fuel Technology, Sheffield University.

MR. S. H. BUSCH has been appointed chairman and Mr. H. S. Lamburd managing director of Asea Electric, Ltd.

E. H. JONES (MACHINE TOOLS), Ltd., has opened new offices at 42, Frederick Street, Edinburgh, 2, in charge of Mr. W. K. McCready.

LIEUT.-COLONEL E. BRIGGS and Major F. D. Napier-Clavering have been appointed directors of W. J. Fraser and Co., Ltd., Dagenham.

MR. C. S. GILL has been re-elected Chairman of the British Steel Founders' Association. Mr. F. A. Martin has been elected Vice-Chairman.

MR. P. ERIC MILLBOURN has been appointed chairman of Spencer (Melksham), Ltd., in succession to Mr. W. Littlejohn Philip, who has retired.

CHANCE BROTHERS, Ltd., announces that the "Umbroc" shadow factory at St. Helens, Lancs, has been reopened for the production of raw optical glass.

DELORO STELLITE, Ltd., has appointed Mr. P. B. Ward as machining specialist. His services will be available in an advisory capacity and for demonstrations.

MR. F. A. FOX is relinquishing his position as chief metallurgist of Magnesium Elektron, Ltd., and is joining the staff of the British Welding Research Association, Ltd.

MR. E. T. JUDGE, chief engineer of Dorman, Long and Co., Ltd., has been appointed a director of the company. Mr. E. K. Scott has been appointed a special director.

MR. F. H. BEASANT has been appointed manager of the traction division of Crompton Parkinson, Ltd., in succession to Mr. H. G. McClean, who is taking up a post in the U.S.A.

THE MANCHESTER GEOLOGICAL AND MINING SOCIETY has changed its address to the Wigan and District Mining and Technical College, Library Street, Wigan (telephone, Wigan 2554).

MR. P. C. SHARP, Mr. J. H. R. Nixon, Mr. B. L. Metcalf, Mr. D. S. A. E. Jessop and Colonel H. T. Thornley have been appointed local directors of Brush Electrical Engineering Company, Ltd.

MR. A. BRADBURY has been appointed assistant commercial manager of the Staveley Coal and Iron Company, Ltd. Mr. Arthur Slater has been appointed manager of the chemical sales department.

MR. R. WEAVING, M.I.E.E., has retired from the position of general manager of the British Electric Transformer Company, Ltd. He remains a director of the company. Mr. E. T. R. Ball has been appointed to succeed Mr. Weaving as general manager.

THE UNITED WIRE WORKS, Ltd., has decided to dispense with the trading names of the Patent Process Wire Weaving Company and Granton Wire Mills. All transactions are now to be conducted in the name of the United Wire Works, Ltd., Granton, Edinburgh, 5.

THE GOVERNOR OF NORTHERN IRELAND has appointed Mr. George B. Hanna, K.C., Mr. H. E. A. Addy, F.C.A., and Professor F. T. Lloyd-Dodd, M.A., D.Sc., to be the Transport Appeal Tribunal for Northern Ireland for the purposes of the Road and Railway Transport Act (N.I.), 1935, until March 31st, 1947.